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Water and Waste Management

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Development Document for Effluent Limitations Guidelines and Standards for the Pesticides

Proposed

Point Source Category

DEVELOPMENT DOCUMENT

FOR

EXPANDED BEST PRACTICABLE CONTROL TECHNOLOGY, BEST CONVENTIONAL POLLUTANT CONTROL TECHNOLOGY, BEST AVAILABLE TECHNOLOGY, NEW SOURCE PERFORMANCE TECHNOLOGY, AND PRETREATMENT TECHNOLOGY

IN THE

PESTICIDE CHEMICALS INDUSTRY

U.S. ENVIRONMENTAL PROTECTION AGENCY

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on Agency

ABSTRACT

The purpose of this report is to provide a technical data base for proposal of effluent limitations guidelines by the U.S. Environmental Protection Agency for the Pesticide Chemicals Industry.

Effluent limitations guidelines for expanded Best Practicable Control Technology Currently Available (BPT), Best Conventional Pollutant Control Technology (BCT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for Existing Sources (PSES) and New Sources (PSNS) will be proposed under authority of Sections 301, 304, 306, 307 (b) and (c) of the amended Clean Water Act from the results of this study and review by EPA. Guidelines will address 126 priority pollutants, as well as conventional and nonconventional pollutants (BOD, COD, TSS, Pesticides, and pH) which were not previously regulated at 40 CFR, Part 455 (BPT, 1978).

Analytical methods were developed, during the verification sampling portion of this study, using Gas or Liquid Chromatography (GC or LC) for priority pollutants and nonconventional pollutant pesticide parameters at 16 pesticide manufacturing facilities. The results of these analyses were evaluated along with data from EPA-conducted screening sampling programs at 30 plants and from sampling by the manufacturers themselves. In conjunction with these data a process chemistry evaluation of 280 individual pesticide processes was made in order to define priority pollutants sources likely to be present where no monitoring data were available.

The principal groups of pollutants detected or likely to be present in untreated pesticide process wastewaters were: phenols, volatiles (aromatics, halomethanes, and chlorinated ethanes and ethylenes), nitrosamines, dienes, cyanide, copper, zinc, and pesticides.

Treatment units recommended for the control of these pollutants are activated carbon, resin adsorption, hydrolysis, steam stripping, chemical oxidation, metals separation, and biological oxidation. These treatment units are currently installed and operating in the industry.

Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

NOTE TO THE READER

This report and the industry it covers are admittedly complex. The following typical questions and answers are provided to assist the reader:

Q. What pesticides are included in this study?

A. See page III-2 for classes of pesticides; see Section XXI--Appendix 3 for alphabetical listing.

Q. What priority pollutants are included in this study?

A. Section XXI--Appendix 1 lists priority pollutants individually and by groups as they are discussed in this report. The 34 priority pollutants recommended for regulation are listed in Section II.

Q. What pollutants and levels are regulated for specific pesticides?

A. For metallo-organic pesticide manufacturers of mercury, cadmium, copper, or arsenic-based products and pesticide formulators and packagers, refer to Tables II-5 and II-6 (BCT), II-18 and II-19 (BAT), II-31 and II-32 (NSPS), and II-44 and II-45 (PSES and PSNS), respectively. For all other pesticides follow this three-step procedure:

1. Determine pollutants to be monitored in specific pesticide wastewater (see Section XXI--Appendix 9).

2. Determine subcategory for specific pesticide (see Section XXI--Appendix 3).

3. Determine pollutants and levels to be regulated--from subcategory number listed in 2, above. See appropriate Tables II-1 through II-3 (expanded BPT), II-4 (BCT), II-7 through II-17 (BAT), II-20 through II-30 (NSPS), and II-33 through II-43 (PSES and PSNS). In appropriate table, only those pollutants listed in 1, above, will be regulated.

Q. How are metallo-organic pesticides with mercury, cadmium, copper, or arsenic-bases distinguished from other manufactured pesticide products in this report?

A. The metallo-organic pesticides with mercury, cadmium, copper, or arsenic-bases are discussed as a class of compounds under separate subsections from all other manufactured products where appropriate (see Sections II, IV, VII, XII, XIII, and XIV).

Q. What treatment is recommended to achieve regulations?

A. See Table VII-1.

Q. What will it cost to achieve regulations?

A. Estimated total for industry is included within each regulation section of this report; see Section X for expanded BPT, Section XII for BAT, Section XIII for NSPS, and Section XIV for PSES and PSNS. Individual plant/pesticide estimates are included in the administrative record, not in this report. Treatment unit cost curves are found in Figures VIII-1 through VIII-21.

Q. Whom should I call for answers to additional questions?

A. Mr. George M. Jett, U.S. EPA, Effluent Guidelines Division, (202) 382-7180.

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SECTION I

CONCLUSIONS

This report summarizes work conducted since February 1978 concerning the technical basis for proposal of effluent limitations guidelines for the Pesticide Chemicals Industry.

The scope of the study included 280 pesticides manufactured by 117 plants. Forty-two of these plants discharge process wastewater to navigable waters, 37 are indirect dischargers, and the remainder dispose of wastewater by deep well injection, incineration, contract hauling, evaporation ponds, land, or ocean discharge. Eleven plants generate no wastewater. Metallo-organic pesticide manufacturers of mercury, copper, cadmium, and arsenic-based products and pesticide formulator/packagers are also included in the scope of this study.

The principal groups of priority pollutants detected or likely to be present in untreated pesticide wastewaters were found to be: volatile aromatics, halomethanes, phenols, cyanides, chlorinated ethanes and ethylenes, metals (copper and zinc), nitrosamines, dienes, and pesticides. Nonconventional pollutant pesticides were found at concentrations greater than 1 mg/l in approximately 75 percent of all untreated pesticide wastewaters sampled.

The major treatment units currently employed by plants in the industry are: biological oxidation, activated carbon, incineration, chemical oxidation, hydrolysis, steam stripping, multimedia filtration, resin adsorption, and metals separation. It was determined that these units, when properly designed and operated, could effectively remove the principal priority pollutants, conventional pollutants, and pesticides found in process wastewaters. Data transfer for treatment by metals separation (electroplating industry), for steam stripping (organic chemicals industry), and for cyanide removal by chemical oxidation (electroplating industry) was utilized where data were absent or performance judged inadequate in the pesticide industry. Performance data from other industrial categories indicating the effectiveness of these technologies for removal of priority pollutants present in the pesticide industry wastewaters were analyzed and, if judged applicable based upon design and historical performance of a treatment technology, were incorporated into the data base from which these proposed regulations were developed. EPA has determined that performance data from other industrial categories can be transferred to the pesticides industry because regardless of the origin of the wastewater, these certain technologies are routinely effective in removing specific pollutants.

Analytical methods are currently available for detecting in wastewater 112 of the nonconventional pesticide pollutants in the scope of this study. Proposed EPA 304(h) analytical methods are available for all 126 priority pollutants (U.S. EPA, 1979b). All available industry analytical methods for nonconventional pesticides and priority pollutants have been requested and received and are part of the administrative record for this industry. The Agency intends to propose industry analytical methods in 40 CFR Part 455 in January 1983.

SECTION II

PROPOSALS

The U.S. Environmental Protection Agency is proposing effluent limitations guidelines for BPT, for pesticides excluded from prior regulation, hereafter termed expanded BPT, and for BAT, NSPS, BCT, and pretreatment standards for new and existing sources of the Pesticide Chemicals Industry based upon review and evaluation of technical information contained in this document, comments from reviewers of this document, and other information as appropriate.

It is proposed that the 280 pesticides in the scope of this study be assigned to 11 subcategories for proposal of effluent limitations guidelines (one subcategory is proposed to be zero discharge), as identified in Tables VII-2 and VII-3 of this report. It is proposed that metallo-organic pesticide manufacturers of mercury, cadmium, copper, or arsenic-based products and formulator/packagers of pesticide active ingredients be assigned to a twelfth and thirteenth subcategory, respectively, where the proposed pretreatment standard be set at zero discharge (see Table VII-4 of this report). The rationale for this proposal is found in Section VII.

It is proposed that 34 priority pollutants be regulated in order to adequately control the discharge of 70 priority pollutants (the remaining pollutants are proposed not to be regulated pending the collection of additional data). The rationale for this proposal is found in Section IX. The 34 priority pollutants proposed to be regulated are as follows:

- Volatile Aromatics
  - Benzene
  - Chlorobenzene
  - 1,2-Dichlorobenzene
  - 1,4-Dichlorobenzene
  - Toluene
  - 1,2,4-Trichlorobenzene
- Halomethanes
  - Carbon tetrachloride
  - Chloroform
  - Methyl bromide
  - Methyl chloride
  - Methylene chloride
- Metals
  - Copper
  - Zinc
- Cyanide
  - Cyanide
- Haloethers
  - Bis(2-chloroethyl) ether
- Phenols
  - 2,4-Dichlorophenol
  - 2,4-Dinitrophenol
  - 4-Nitrophenol
  - Pentachlorophenol
  - Phenol
- Pesticides
  - BHC, alpha
  - BHC, beta
  - BHC, delta
  - Endosulfan, alpha
  - Endosulfan, beta

Chlorinated Ethanes and Ethylenes
- 1,2-Dichloroethane
- Tetrachloroethylene

Nitrosamines
- N-nitrosodi-n-propylamine

Dichloropropane and Dichloropropene
- 1,3-Dichloropropene

Pesticides (Continued)
- Endrin
- Heptachlor
- Lindane (BHC, gamma)
- Toxaphene

Dienes
- Hexachlorocyclopentadiene

It is further proposed that 137 nonconventional pollutant pesticides be regulated to the levels shown in the following tables. The rationale for this proposal is found in Section XV.

The treatment units recommended to achieve these levels for Subcategories 1 through 10 are listed below, and the rationale for this recommendation is found in Section VI.

Steam Stripping
Chemical Oxidation
Metals Separation
Pesticide Removal (Activated Carbon, Resin Adsorption, Hydrolysis)
Biological Oxidation

The treatment/disposal units recommended to achieve the proposed levels for Subcategories 11 through 13 are listed below, and the rationale for this recommendation is found in Section VI.

Recycle and Reuse
Contract Hauling
Evaporation

It is proposed that expanded BPT for direct discharger manufacturers equal BPT for conventional pollutants and COD (see Section X). The proposed effluent limitations for expanded BPT are shown in Tables II-1 through II-3.

It is proposed that BCT for zero dischargers equal zero discharge for BOD and TSS for Subcategories 11, 12, and 13 (see Section XI). The proposed effluent limitations for BCT are shown in Tables II-4 through II-6.

It is proposed that BAT for direct discharger manufacturers equal the levels presented in Tables II-7 through II-17 for the priority pollutant and nonconventional pesticide parameters. It is also proposed that BAT for existing formulating/packaging sources and metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products be equal to the BPT direct discharge limitation. The proposed BAT limitations for formulator/packagers and these select metallo-organic pesticide manufacturers are shown in Tables II-18 and II-19. The rationale for this proposal is found in Section XII.

It is proposed that NSPS for new direct discharger manufacturers equal BAT for the priority pollutant and nonconventional pesticide parameters and equal BPT for conventional pollutants and COD. It is also proposed that NSPS for new direct discharge formulator/packagers and

metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products be proposed as zero wastewater discharge. The proposed effluent limitations for NSPS are shown in Tables II-20 through II-32. The rationale for these proposals is discussed in Section XIII.

It is proposed that pretreatment standards for new and existing manufacturing sources (PSNS and PSES) be equal to BAT levels without biological treatment, since biological treatment is costly and does not justify the incremental removal of priority and nonconventional pesticide pollutants. It is also proposed that pretreatment standards for new and existing formulating/packaging sources and metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products be equal to the NSPS direct discharge limitation. The proposed pretreatment standards for the priority pollutant and nonconventional pesticide parameters are shown in Tables II-33 through II-45. The rationale for this proposal is found in Section XIV.

Table II-1. Proposed Expanded BPT Limitations for Subcategory 1

Parameter	Effluent Limitations* 30-Day Maximum Average•	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
COD†	9.	13.
CONVENTIONAL POLLUTANTS†		
BOD	1.6	7.4
TSS	1.8	6.1
pH	**	**

* All units are lbs/1,000 lbs (kg/kkg).

• Average of daily values for 30 consecutive days.

† Applies only to atrazine (Plant 1), benzyl benzoate, biphenyl (Plant 2), coumachlor, coumafuryl, coumatetralyl, diphacinone, endothall, EXD, methoprene, 1,8-naphthalic anhydride, piperonyl butoxide, propargite, and warfarin.

** The pH shall be between the values of 6.0 to 9.0.

Table II-2. Proposed Expanded BPT Limitations for Subcategory 2

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
COD†	9.	13.
CONVENTIONAL POLLUTANTS†		
BOD	1.6	7.4
TSS	1.8	6.1
pH	**	**

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to allethrin, chlorophacinone, glyphosate, hexazinone, phenylphenol, phenylphenol sodium salt, quinomethionate, rotenone, and sulfoxide.

** The pH shall be between the values of 6.0 to 9.0.

Table II-3. Proposed Expanded BPT Limitations for Subcategory 10

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
COD†	9.	13.
CONVENTIONAL POLLUTANTS†		
BOD	1.6	7.4
TSS	1.8	6.1
pH	**	**

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory.

** The pH shall be between the values of 6.0 and 9.0.

Table II-4. Proposed BCT Limitations for Subcategory 11

Parameter	Effluent Limitations 30-Day Maximum Average°	Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS*	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

* Applies to all pesticides in this subcategory.

Table II-5. Proposed BCT Limitations for Subcategory 12

Parameter	Effluent Limitations 30-Day Maximum Average*	Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS†	ZERO DISCHARGE	

* Average of daily values for 30 consecutive days.

† Applies to all wastewaters from metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products.

Table II-6. Proposed BCT Limitations for Subcategory 13

Parameter	Effluent Limitations 30-Day Maximum Average*	Daily Maximum
PROCESS WASTEWATER POLLUTANTS FROM FORMULATION OR PACKAGING OF ALL PESTICIDE ACTIVE INGREDIENTS	ZERO DISCHARGE	

* Average of daily values for 30 consecutive days.

Table II-7. Proposed BAT Limitations for Subcategory 1

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0457	0.258
PRIORITY POLLUTANTS**		
2,4-Dinitrophenol	0.00718	0.0133
Phenol	0.00474	0.0133
N-nitrosodi-n-propylamine	0.0000485	0.000169

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to atrazine (Plant 3), benomyl, busan 40, busan 85, carbam-S, carbofuran, coumaphos, DBCP, dichlorvos, dinoseb, dioxathion, ferbam, isopropalin, KN methyl, metham, mevinphos, niacide, oxamyl, PCP salt, phorate, terbacil, terbufos, and tricyclazole.

** Applies to all pesticides in this subcategory, as necessary.

Table II-8. Proposed BAT Limitations for Subcategory 2

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0751	0.339
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Chlorobenzene	0.000870	0.00278
Toluene	0.000781	0.00278
1,2-Dichlorobenzene††	0.0751	0.339
1,4-Dichlorobenzene††	0.0751	0.339
1,2,4-Trichlorobenzene††	0.0751	0.339
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl bromide	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
2,4-Dichlorophenol	0.00718	0.0133
4-Nitrophenol	0.00984	0.0133
Pentachlorophenol	0.00718	0.0133
Phenol	0.00474	0.0133
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278
N-nitrosodi-n-propylamine	0.0000485	0.000169

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to alachlor, AOP, benfluralin, bentazon, bolstar, bromacil, butachlor, carbendazim, carbophenothion, chlorobenzilate, chlorpyrifos, chlorpyrifos methyl, 2,4-D isobutyl ester, 2,4-D isooctyl ester (Plant 4), 2,4-DB, 2,4-DB isobutyl ester, 2,4-DB isooctyl ester, deet, demeton, dichlofenthion, ethalfluralin, ethion, etridiazole, fenthion, glyphosate, hexazinone, mephosfolan, methomyl, nabam, naled, profluralin, propachlor, ronnel, stirofos, triadimefon, and trichloronate.

Table II-8. Proposed BAT Limitations for Subcategory 2
(Continued, Page 2 of 2)

** Applies to all pesticides in this subcategory, as necessary.

†† Proposed for regulation only in those processes in which it is the manufactured product; proposed for exclusion from regulation in all other processes where it is expected to be controlled by the regulation of chlorobenzene.

Table II-9. Proposed BAT Limitations for Subcategory 3

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.00662	0.0359
PRIORITY POLLUTANTS**		
Zinc	0.0122	0.0282

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to mancozeb, maneb, zineb (Plant 5), and ziram (Plants 6 and 7).

** Applies to all pesticides in this subcategory, as necessary.

Table II-10. Proposed BAT Limitations for Subcategory 4

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0018	0.01
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
Cyanide	0.00119	0.00244
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to fluometuron.

** Applies to all pesticides in this subcategory, as necessary.

Table II-11. Proposed BAT Limitations for Subcategory 5

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.00234	0.0127
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
Copper	0.0118	0.0363
Zinc	0.0122	0.0282
Hexachlorocyclopentadiene	0.00122	0.00325

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to fensulfothion, ZAC, and zineb (Plant 8).

** Applies to all pesticides in this subcategory, as necessary.

Table II-12. Proposed BAT Limitations for Subcategory 6

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
PRIORITY POLLUTANTS†		
Cyanide	0.00119	0.00244

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

Table II-13. Proposed BAT Limitations for Subcategory 7

Parameter	Effluent Limitations* 30-Day Maximum Average•	Daily Maximum
PRIORITY POLLUTANTS†		
Benzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
Copper	0.0118	0.0363
Cyanide	0.00119	0.00244

* All units are lbs/1,000 lbs (kg/kkg).

• Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

Table II-14. Proposed BAT Limitations for Subcategory 8

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
PRIORITY POLLUTANTS†		
2,4-Dinitrophenol	0.00718	0.0133
4-Nitrophenol	0.00984	0.0133
Phenol	0.00474	0.0133
N-nitrosodi-n-propylamine	0.0000485	0.000169
Hexachlorocyclopentadiene	0.00122	0.00325

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

Table II-15. Proposed BAT Limitations for Subcategory 9

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
PRIORITY POLLUTANTS†		
Benzene	0.000870	0.00278
Chlorobenzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
Hexachlorocyclopentadiene	0.00122	0.00325
2,4-Dichlorophenol	0.00718	0.0133
2,4-Dinitrophenol	0.00718	0.0133
4-Nitrophenol	0.00984	0.0133
Pentachlorophenol	0.00718	0.0133
Phenol	0.00474	0.0133
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

Table II-16. Proposed BAT Limitations for Subcategory 10

Parameter	Effluent Limitations* 30-Day Maximum Average•	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0838	0.439
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Chlorobenzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl bromide	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278
Cyanide	0.00119	0.00244

* All units are lbs/1,000 lbs (kg/kkg).

• Average of daily values for 30 consecutive days.

† Applies only to ametryne, atrazine (Plants 9 and 10), cyanazine, metribuzin, prometon, prometryn, propazine, simazine, simetryne, terbuthylazine, and terbutryn.

** Applies to all pesticides in this subcategory, as necessary.

Table II-17. Proposed BAT Limitations for Subcategory 11

Parameter	Effluent Limitations 30-Day Maximum Average°	Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS*	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

* Applies to all wastewaters from manufacture of the nonconventional pesticides alkylamine hydrochloride, amobam, barban, BBTAC, biphenyl (Plant 11), chloropicrin (Plants 12, 13, 14), 2,4-D isooctyl ester (Plant 15), 2,4-D salt, D-D, dichlorophen salt, dowicil 75, ethoprop, fluoroacetamide, glyodin, HPTMS, merphos, metasol J-26, pyrethrin, silvex isooctyl ester, silvex salt, sodium monofluoroacetate (Plant 16), tributyltin benzoate, tributyltin oxide (Plant 17), vancide TH, vancide 51Z, vancide 51Z dispersion, and ziram (Plant 18). Also applies to all wastewaters from dichloroethyl ether and dichloropropene in those processes in which it is the manufactured product. Dichloroethyl ether and dichloropropene are proposed to be excluded from regulation in all other processes due to a lack of adequate monitoring data.

Table II-18. Proposed BAT Limitations for Subcategory 12

Parameter	Effluent Limitations 30-Day Maximum Average°	Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS†	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

† Applies to all wastewaters from metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products.

Table II-19. Proposed BAT Limitations for Subcategory 13

Parameter	Effluent Limitations 30-Day Maximum Average°	Daily Maximum
PROCESS WASTEWATER POLLUTANTS FROM FORMULATION OR PACKAGING OF ALL PESTICIDE ACTIVE INGREDIENTS	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

Table II-20. Proposed NSPS Limitations for Subcategory 1

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0457	0.258
COD°°	9.	13.
PRIORITY POLLUTANTS**		
2,4-Dinitrophenol	0.00718	0.0133
Phenol	0.00474	0.0133
N-nitrosodi-n-propylamine	0.0000485	0.000169
CONVENTIONAL POLLUTANTS°°		
BOD	1.6	7.4
TSS	1.8	6.1
pH	††	††

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to atrazine (Plant 19 process), benomyl, busan 40, 85, carbam-S, carbofuran, coumaphos, DBCP, dichlorvos, dinoseb, dioxathion, ferbam, phorate, isopropalin, KN methyl, metham, mevinphos, niacide, oxamyl, PCP salt, terbacil, terbufos, and tricyclazole.

** Applies to all pesticides in this subcategory, as necessary.

†† The pH shall be between the values of 6.0 to 9.0.

°° Applies to all pesticides in this subcategory.

Table II-21. Proposed NSPS Limitations for Subcategory 2

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0751	0.339
COD***	9.	13.
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Chlorobenzene	0.000870	0.00278
Toluene	0.000781	0.00278
1,2-Dichlorobenzene††	0.0751	0.339
1,4-Dichlorobenzene††	0.0751	0.339
1,2,4-Trichlorobenzene††	0.0751	0.339
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl bromide	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
2,4-Dichlorophenol	0.00718	0.0133
4-Nitrophenol	0.00984	0.0133
Pentachlorophenol	0.00718	0.0133
Phenol	0.00474	0.0133
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278
N-nitrosodi-n-propylamine	0.0000485	0.000169
CONVENTIONAL POLLUTANTS***		
BOD	1.6	7.4
TSS	1.8	6.1
pH	°°	°°

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

Table II-21. Proposed NSPS Limitations for Subcategory 2
(Continued, Page 2 of 2)

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† Applies only to alachlor, AOP, benfluralin, bentazon, bolstar, bromacil, butachlor, carbendazim, carbophenothion, chlorobenzilate, chlorpyrifos, chlorpyrifos methyl, 2,4-D isobutyl ester, 2,4-D isooctyl ester (Plant 20 process), 2,4-DB, 2,4-DB isobutyl ester, 2,4-DB isooctyl ester, deet, demeton, dichlofenthion, ethalfluralin, ethion, etridiazole, fenthion, glyphosate, hexazinone, mephosfolan, methomyl, nabam, naled, profluralin, propachlor, ronnel, stirofos, triadimefon, and trichloronate.

** Applies to all pesticides in this subcategory, as necessary.

†† Recommended for regulation only in those processes in which it is the manufactured product; recommended for exclusion from regulation in all other processes where it is expected to be controlled by regulation of chlorobenzene.

°° The pH shall be between the values of 6.0 to 9.0.

*** Applies to all pesticides in this subcategory.

Table II-22. Proposed NSPS Limitations for Subcategory 3

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.00662	0.0359
COD°°	9.	13.
PRIORITY POLLUTANTS**		
Zinc	0.0122	0.0282
CONVENTIONAL POLLUTANTS°°		
BOD	1.6	7.4
TSS	1.8	6.1
pH	††	††

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to mancozeb, maneb, zineb (Plant 21 process), and ziram (Plants 22 and 23 processes).

** Applies to all pesticides in this subcategory, as necessary.

†† The pH shall be between the values of 6.0 to 9.0.

°° Applies to all pesticides in this subcategory.

Table II-23. Proposed NSPS Limitations for Subcategory 4

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0018	0.01
COD°°	9.	13.
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
Cyanide	0.00119	0.00244
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278
CONVENTIONAL POLLUTANTS°°		
BOD	1.6	7.4
TSS	1.8	6.1
pH	††	††

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to fluometuron.

** Applies to all pesticides in this subcategory, as necessary.

†† The pH shall be between the values of 6.0 to 9.0.

°° Applies to all pesticides in this subcategory.

Table II-24. Proposed NSPS Limitations for Subcategory 5

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.00234	0.0127
COD°°	9.	13.
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
Copper	0.0118	0.0363
Zinc	0.0122	0.0282
Hexachlorocyclopentadiene	0.00122	0.00325
CONVENTIONAL POLLUTANTS°°		
BOD	1.6	7.4
TSS	1.8	6.1
pH	††	††

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to fensulfothion, ZAC, and zineb (Plant 24 process).

** Applies to all pesticides in this subcategory, as necessary.

†† The pH shall be between the values of 6.0 to 9.0.

°° Applies to all pesticides in this subcategory.

Table II-25. Proposed NSPS Limitations for Subcategory 6

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS††		
COD	9.	13.
PRIORITY POLLUTANTS†		
Cyanide	0.00119	0.00244
CONVENTIONAL POLLUTANTS††		
BOD	1.6	7.4
TSS	1.8	6.1
pH	**	**

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

** The pH shall be between the values of 6.0 to 9.0.

†† Applies to all pesticides in this subcategory.

Table II-26. Proposed NSPS Limitations for Subcategory 7

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS††		
COD	9.	13.
PRIORITY POLLUTANTS†		
Benzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
Copper	0.0118	0.0363
Cyanide	0.00119	0.00244
CONVENTIONAL POLLUTANTS††		
BOD	1.6	7.4
TSS	1.8	6.1
pH	**	**

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

** The pH shall be between the values of 6.0 to 9.0.

†† Applies to all pesticides in this subcategory.

Table II-27. Proposed NSPS Limitations for Subcategory 8

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0018	0.010
COD°°	9.	13.
PRIORITY POLLUTANTS**		
2,4-Dinitrophenol	0.00718	0.0133
4-Nitrophenol	0.00984	0.0133
Phenol	0.00474	0.0133
Endosulfan, alpha	0.0018	0.010
Endosulfan, beta	0.0018	0.010
Heptachlor	0.0018	0.010
N-nitrosodi-n-propylamine	0.0000485	0.000169
Hexachlorocyclopentadiene	0.00122	0.00325
CONVENTIONAL POLLUTANTS°°		
BOD	1.6	7.4
TSS	1.8	6.1
pH	††	††

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to aminocarb, fenuron, malathion, methiocarb, mexacarbate, mirex, monuron, parathion ethyl, parathion methyl, propham, propoxur, and trifluralin.

** Applies to all pesticides in this subcategory, as necessary.

†† The pH shall be between the values of 6.0 to 9.0.

°° Applies to all pesticides in this subcategory.

Table II-28. Proposed NSPS Limitations for Subcategory 9

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0018	0.010
COD	9.	13.
PRIORITY POLLUTANTS**		
Benzene	0.000870	0.00278
Chlorobenzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
BHC, alpha	0.0018	0.010
BHC, beta	0.0018	0.010
BHC, delta	0.0018	0.010
Endrin	0.0018	0.010
Heptachlor	0.0018	0.010
Lindane (BHC, gamma)	0.0018	0.010
Toxaphene	0.0018	0.010
Hexachlorocyclopentadiene	0.00122	0.00325
2,4-Dichlorophenol	0.00718	0.0133
2,4-Dinitrophenol	0.00718	0.0133
4-Nitrophenol	0.00984	0.0133
Pentachlorophenol	0.00718	0.0133
Phenol	0.00474	0.0133
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278

Table II-28. Proposed NSPS Limitations for Subcategory 9
(Continued, Page 2 of 2)

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
CONVENTIONAL POLLUTANTS°°		
BOD	1.6	7.4
TSS	1.8	6.1
pH	††	††

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to azinphos methyl, captan, carbaryl, chlorpropham, 2,4-D, DCNA, demeton-o, demeton-s, diazinon, dicamba, dicofol, disulfoton, diuron, fenuron-TCA, linuron, methoxychlor, monuron-TCA, neburon, PCNB, perthane, siduron, silvex, SWEP, and 2,4,5-T.

** Applies to all pesticides in this subcategory, as necessary.

†† The pH shall be between the values of 6.0 to 9.0.

°° Applies to all pesticides in this subcategory.

Table II-29. Proposed NSPS Limitations for Subcategory 10

Parameter	Effluent Limitations* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0838	0.439
COD**	9.	13.
PRIORITY POLLUTANTS††		
Benzene	0.000870	0.00278
Chlorobenzene	0.000870	0.00278
Toluene	0.000781	0.00278
Carbon tetrachloride	0.00111	0.00278
Chloroform	0.00111	0.00278
Methyl bromide	0.00111	0.00278
Methyl chloride	0.00111	0.00278
Methylene chloride	0.00111	0.00278
1,2-Dichloroethane	0.00944	0.0278
Tetrachloroethylene	0.00944	0.0278
Cyanide	0.00119	0.00244
CONVENTIONAL POLLUTANTS**		
BOD	1.6	7.4
TSS	1.8	6.1
pH	°°	°°

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to ametryne, atrazine (Plants 25 and 26 processes), cyanazine, metribuzin, prometon, prometryn, propazine, simazine, simetryne, terbuthylazine, and terbutryn.

** Applies to all pesticides in this subcategory.

†† Applies to all pesticides in this subcategory, as necessary.

°° The pH shall be between the values of 6.0 and 9.0.

Table II-30. Proposed NSPS Limitations for Subcategory 11

Parameter	Effluent Limitations 30-Day Maximum Average°	Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS*	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

* Applies to all wastewaters from manufacture of the nonconventional pesticides alkylamine hydrochloride, amobam, barban, BBTAC, biphenyl (Plant 27 process), chloropicrin (Plants 28, 29, 30 processes), 2,4-D isooctyl ester (Plant 31 process), 2,4-D salt, D-D, dichlorophen salt, dowicil 75, ethoprop, fluoroacetamide, glyodin, HPTMS, merphos, metasol J-26, pyrethrin, silvex isooctyl ester, silvex salt, sodium monofluoroacetate (Plant 32 process), tributyltin benzoate, tributyltin oxide (Plant 33 process), vancide TH, vancide 51Z, vancide 51Z dispersion, and ziram (Plant 34 process). Also applies to all wastewaters from dichloroethyl ether and dichloropropene in those processes in which it is the manufactured product. Dichloroethyl ether and dichloropropene are proposed to be excluded from regulation in all other processes due to a lack of adequate monitoring data.

Table II-31. Proposed NSPS Limitations for Subcategory 12

Parameter	Effluent Limitations 30-Day Maximum Average°	Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS†	*ZERO DISCHARGE*	

° Average of daily values for 30 consecutive days.

† Applies to all wastewaters from metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products.

Table II-32. Proposed NSPS Limitations for Subcategory 13

Parameter	Effluent Limitations 30-Day Maximum Average°	Daily Maximum
PROCESS WASTEWATER POLLUTANTS FROM FORMULATION OR PACKAGING OF ALL PESTICIDE ACTIVE INGREDIENTS	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

Table II-33. Proposed Standards for PSES and PSNS for Subcategory 1

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0528	0.299
PRIORITY POLLUTANTS**		
2,4-Dinitrophenol	0.0718	0.133
Phenol	0.0474	0.133
N-nitrosodi-n-propylamine	0.0000485	0.000169

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to atrazine (Plant 35), benomyl, busan 40, busan 85, carbam-S, carbofuran, coumaphos, DBCP, dichlorvos, dinoseb, dioxathion, ferbam, isopropalin, KN methyl, metham, mevinphos, niacide, oxamyl, PCP salt, phorate, terbacil, terbufos, and tricyclazole.

** Applies to all pesticides in this subcategory, as necessary.

Table II-34. Proposed Standards for PSES and PSNS for Subcategory 2

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.134	0.605
PRIORITY POLLUTANTS**		
Benzene	0.0870	0.278
Chlorobenzene	0.0870	0.278
Toluene	0.0781	0.278
1,2-Dichlorobenzene††	0.134	0.605
1,4-Dichlorobenzene††	0.134	0.605
1,2,4-Trichlorobenzene††	0.134	0.605
Carbon tetrachloride	0.111	0.278
Chloroform	0.111	0.278
Methyl bromide	0.111	0.278
Methyl chloride	0.111	0.278
Methylene chloride	0.111	0.278
2,4-Dichlorophenol	0.0718	0.133
4-Nitrophenol	0.0984	0.133
Pentachlorophenol	0.0718	0.133
Phenol	0.0474	0.133
1,2-Dichloroethane	0.0944	0.278
Tetrachloroethylene	0.0944	0.278
N-nitrosodi-n-propylamine	0.0000485	0.000169

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to alachlor, AOP, benfluralin, bentazon, bolstar, bromacil, butachlor, carbendazim, carbophenothion, chlorobenzilate, chlorpyrifos, chlorpyrifos methyl, 2,4-D isobutyl ester, 2,4-D isooctyl ester (Plant 36), 2,4-DB, 2,4-DB isobutyl ester, 2,4-DB isooctyl ester, deet, demeton, dichlofenthion, ethalfluralin, ethion, etridiazole, fenthion, glyphosate, hexazinone, mephosfolan, methomyl, nabam, naled, profluralin, propachlor, ronnel, stirofos, triadimefon, and trichloronate.

Table II-34. Proposed Standards for PSES and PSNS for Subcategory 2 (Continued, Page 2 of 2)

** Applies to all pesticides in this subcategory, as necessary.

†† Proposed for regulation only in those processes in which it is the manufactured product; proposed for exclusion from regulation in all other processes where it is expected to be controlled by regulation of chlorobenzene.

Table II-35. Proposed Standards for PSES and PSNS for Subcategory 3

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0203	0.110
PRIORITY POLLUTANTS**		
Zinc	0.0247	0.0570

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to mancozeb, maneb, zineb (Plant 37), and ziram (Plants 38 and 39).

** Applies to all pesticides in this subcategory, as necessary.

Table II-36. Proposed Standards for PSES and PSNS for Subcategory 4

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.00340	0.0185
PRIORITY POLLUTANTS**		
Benzene	0.0870	0.278
Toluene	0.0781	0.278
Carbon tetrachloride	0.111	0.278
Chloroform	0.111	0.278
Methyl chloride	0.111	0.278
Methylene chloride	0.111	0.278
Cyanide	0.00238	0.00488
1,2-Dichloroethane	0.0944	0.278
Tetrachloroethylene	0.0944	0.278

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to fluometuron.

** Applies to all pesticides in this subcategory, as necessary.

Table II-37. Proposed Standards for PSES and PSNS for Subcategory 5

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0255	0.138
PRIORITY POLLUTANTS**		
Benzene	0.0870	0.278
Toluene	0.0781	0.278
Carbon tetrachloride	0.111	0.278
Chloroform	0.111	0.278
Methyl chloride	0.111	0.278
Methylene chloride	0.111	0.278
Copper	0.0238	0.0733
Zinc	0.0247	0.0570
Hexachlorocyclopentadiene	0.00241	0.00643

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to fensulfothion, ZAC, and zineb (Plant 40).

** Applies to all pesticides in this subcategory, as necessary.

Table II-38. Proposed Standards for PSES and PSNS for Subcategory 6

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
PRIORITY POLLUTANTS†		
Cyanide	0.00238	0.00488

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

Table II-39. Proposed Standards for PSES and PSNS for Subcategory 7

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
PRIORITY POLLUTANTS†		
Benzene	0.0870	0.278
Toluene	0.0781	0.278
Carbon tetrachloride	0.111	0.278
Chloroform	0.111	0.278
Methyl chloride	0.111	0.278
Methylene chloride	0.111	0.278
Copper	0.0238	0.0733
Cyanide	0.00238	0.00488

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies to all pesticides in this subcategory, as necessary.

Table II-40. Proposed Standards for PSES and PSNS for Subcategory 8

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0018	0.010
PRIORITY POLLUTANTS**		
2,4-Dinitrophenol	0.0718	0.133
4-Nitrophenol	0.0984	0.133
Phenol	0.0474	0.133
Endosulfan, alpha	0.0018	0.010
Endosulfan, beta	0.0018	0.010
Heptachlor	0.0018	0.010
N-nitrosodi-n-propylamine	0.0000485	0.000169
Hexachlorocyclopentadiene	0.00241	0.00643

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to aminocarb, fenuron, malathion, methiocarb, mexacarbate, mirex, monuron, parathion ethyl, parathion methyl, propham, propoxur, and trifluralin.

** Applies to all pesticides in this subcategory, as necessary.

Table II-41. Proposed Standards for PSES and PSNS for Subcategory 9

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0018	0.010
PRIORITY POLLUTANTS**		
Benzene	0.0870	0.278
Chlorobenzene	0.0870	0.278
Toluene	0.0781	0.278
Carbon tetrachloride	0.111	0.278
Chloroform	0.111	0.278
Methyl chloride	0.111	0.278
Methylene chloride	0.111	0.278
BHC, alpha	0.0018	0.010
BHC, beta	0.0018	0.010
BHC, delta	0.0018	0.010
Endrin	0.0018	0.010
Heptachlor	0.0018	0.010
Lindane (BHC, gamma)	0.0018	0.010
Toxaphene	0.0018	0.010
Hexachlorocyclopentadiene	0.00241	0.00643
2,4-Dichlorophenol	0.0718	0.133
2,4-Dinitrophenol	0.0718	0.133
4-Nitrophenol	0.0984	0.133
Pentachlorophenol	0.0718	0.133
Phenol	0.0474	0.133
1,2-Dichloroethane	0.0944	0.278
Tetrachloroethylene	0.0944	0.278

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

Table II-41. Proposed Standards for PSES and PSNS for Subcategory 9 (Continued, Page 2 of 2)

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† Applies only to azinphos methyl, captan, carbaryl, chlorpropham, 2,4-D, DCNA, demeton-o, demeton-s, diazinon, dicamba, dicofol, disulfoton, diuron, fenuron-TCA, linuron, methoxychlor, monuron-TCA, neburon, PCNB, perthane, siduron, silvex, SWEP, and 2,4,5-T.

** Applies to all pesticides in this subcategory, as necessary.

Table II-42. Proposed Standards for PSES and PSNS for Subcategory 10

Parameter	Pretreatment Standards* 30-Day Maximum Average°	Daily Maximum
NONCONVENTIONAL POLLUTANTS		
Pesticides†	0.0991	0.519
PRIORITY POLLUTANTS**		
Benzene	0.0870	0.278
Chlorobenzene	0.0870	0.278
Toluene	0.0781	0.278
Carbon tetrachloride	0.111	0.278
Chloroform	0.111	0.278
Methyl bromide	0.111	0.278
Methyl chloride	0.111	0.278
Methylene chloride	0.111	0.278
1,2-Dichloroethane	0.0944	0.278
Tetrachloroethylene	0.0944	0.278
Cyanide	0.00238	0.00488

* All units are lbs/1,000 lbs (kg/kkg).

° Average of daily values for 30 consecutive days.

† Applies only to ametryne, atrazine (Plants 41 and 42), cyanazine, metribuzin, prometon, prometryn, propazine, simazine, simetryne, terbuthylazine, and terbutryn.

** Applies to all pesticides in this subcategory, as necessary.

Table II-43. Proposed Standards for PSES and PSNS for Subcategory 11

Parameter	Pretreatment Standards 30-Day Maximum Average°	Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS*	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

* Applies to all wastewaters from manufacture of the nonconventional pesticides alkylamine hydrochloride, amobam, barban, BBTAC, biphenyl (Plant 43), chloropicrin (Plants 44, 45, 46), 2,4-D isooctyl ester (Plant 47), 2,4-D salt, D-D, dichlorophen salt, dowicil 75, ethoprop, fluoroacetamide, glyodin, HPTMS, merphos, metasol J-26, pyrethrin, silvex isooctyl ester, silvex salt, sodium monofluoroacetate (Plant 48), tributyltin benzoate, tributyltin oxide (Plant 49), vancide TH, vancide 51Z, vancide 51Z dispersion, and ziram (Plant 50). Also applies to all wastewaters from dichloroethyl ether and dichloropropene in those processes in which it is the manufactured product. Dichloroethyl ether and dichloropropene are proposed to be excluded from regulation in all other processes due to a lack of adequate monitoring data.

Table II-44. Proposed Standards for PSES and PSNS for Subcategory 12

Parameter	Pretreatment Standards 30-Day Maximum Average°	Pretreatment Standards Daily Maximum
ALL PROCESS WASTEWATER POLLUTANTS†	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

† Applies to all wastewaters from metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products.

Table II-45. Proposed Standards for PSES and PSNS for Subcategory 13

Parameter	Pretreatment Standards 30-Day Maximum Average°	Pretreatment Standards Daily Maximum
PROCESS WASTEWATER POLLUTANTS FROM FORMULATION OR PACKAGING OF ALL PESTICIDE ACTIVE INGREDIENTS	ZERO DISCHARGE	

° Average of daily values for 30 consecutive days.

SECTION III

INTRODUCTION

PURPOSE AND LEGAL AUTHORITY

United States Environmental Protection Agency (EPA) in February 1978 began this study for the following purposes regarding the Pesticide Chemicals Industry:

1. To review effluent limitations guidelines promulgated pursuant to Sections 301, 304, 306, and 307(b) and (c) of the Federal Water Pollution Control Act Amendments of 1972 ("The Act").

2. To develop an industry profile identifying the potential sources and concentrations, as well as the treatability and economic impact of technology applications, for 129 specific compounds known hereafter as priority pollutants (listed in Section XXI--Appendix 1) and for nonconventional pollutant pesticides (listed in Section XXI--Appendix 3). The priority pollutants were defined as an outgrowth of a court settlement, NRDC v. Train, 8 ERC 2120 (D.D.C. 1976), modified 12 ERC 1833 (D.D.C. 1979). During the course of this study this list of priority pollutants was reduced by the agency to 126; excluded were bis(chloromethyl) ether, trichlorofluoromethane, and dichlorodifluoromethane (U.S. EPA, 1981a and b). The nonconventional pollutant pesticides are those manufactured active ingredients listed in the scope of study below.

The purpose of this document is to provide the technical data base for proposal of effluent limitations guidelines by EPA for Expanded Best Practicable Control Technology Currently Available (Expanded BPT), Best Conventional Pollutant Control Technology (BCT), Best Available Technology Economically Achievable (BAT), New Source Performance Standards (NSPS), and Pretreatment Standards for Existing (PSES) and New (PSNS) Sources for the Pesticide Chemicals Industry as defined in the 1977 amendments to the Clean Water Act. Both conventional and nonconventional pollutants (BOD, TSS, pH, COD, and Pesticides) have been addressed in this review in cases where they were not previously regulated by Best Practicable Control Technology Currently Available (BPT) limitations (see Section XXI--Appendix 2); priority pollutants have been addressed for all pesticides within the scope of this study.

SCOPE OF STUDY

It is important to understand the assumptions under which this study was conducted because of such factors as the complicated nature of the industry itself; the effect of previous regulations and subsequent litigation; and the effect of analytical methods and technical data availability on the conclusions and recommendations which will be made.

Types of Products Covered

This study covers the manufacturing of pesticide active ingredients listed in Section XXI--Appendix 3 of this report. The formulation of these active ingredients into liquids, dusts and powders, or granules, and their subsequent packaging in a marketable container is also covered under this study for new and existing indirect dischargers and new direct dischargers. The manufacture of mercury, cadmium, copper, and arsenic-based pesticides is addressed for new and existing indirect dischargers and new direct dischargers. Direct discharge of wastewaters from these metallo-organic pesticides and formulating/packaging facilities was prohibited by the BPT regulation. In addition, there are 280 pesticide active ingredients covered in the scope of this study, as described below.

The BPT regulation also established effluent limitations for the pesticide parameter in 49 pesticide wastewaters. Two of these pesticides, aldrin and dieldrin, have been banned from manufacture and use by EPA and therefore are not covered in this report. Twenty-five of the previously regulated pesticides are currently manufactured, and when they are combined with 223 currently manufactured pesticides not previously regulated by BPT, a total of 248 pesticides are included in the scope of this study. An additional 22 pesticides regulated under BPT and 10 pesticides excluded from BPT regulations are currently not manufactured; however, they are included in the scope of this study should their manufacture be reactivated, thereby creating a total of 280 pesticides to be studied.

The definition of a pesticide differs among the governmental, industrial, and scientific communities. For the purposes of this study a pesticide is defined as "any technical grade ingredient intended to prevent, destroy, repel, or mitigate any pest, subject to the following categories":

Included in Study

Insecticides	Avicides
Herbicides	Slimicides
Fungicides	Piscicides
Nematicides	Ovicides
Rodenticides	Defoliants
Bactericides	Desiccants
Acaricides	Repellents
Algicides	Synergists
Miticides	Botanicals
Molluscicides	Fumigants

Not Included in Study*

Inorganic Pesticides
Plant Growth Regulators†
Sex Attractants
Quaternary Ammonium Salts††
Microbials
Wood Preservatives**
Disinfectants
Chemosterilants
Pesticides produced outside the United States
Organic, Pharmaceutical, Plastic and Synthetic, or Other Industry Compounds Regulated Elsewhere
Research-Oriented Pesticides Produced in Limited Quantities

* Specific products not included are itemized in the administrative record for the proposed regulation.
† The plant growth regulator maleic hydrazide is included due to its high-volume production.
** The wood preservative pentachlorophenol is included due to its high-volume production.
†† Certain quaternary salts are included due to significant production volume.

Compounds defined in Section XXI—Appendix 1 as "priority pollutant pesticides" are known hereafter as priority pollutants, whereas all other pesticides are referred to as "nonconventional pollutant pesticides."

Definition of Wastewaters Covered

This study assesses only process wastewater associated with the manufacture or formulating/packaging of pesticide active ingredients. As shown in the Glossary, Section XIX, the definition of "process wastewater" adopted is . . . any aqueous discharge which results from or has had contact with the final synthesis step in the manufacturing of pesticide active ingredients, or with the formulating/packaging of those active ingredients, to include the following:

1. Final synthesis reaction wastewater or dilution water step used directly in the process.

2. Wastewater from vessel/floor washing in the immediate manufacturing and formulating/packaging area.

3. Stormwater runoff from the immediate manufacturing and formulating/packaging area.

4. Wastewater from air pollution scrubbers utilized in the manufacturing process or in the immediate manufacturing and formulating/packaging area.

Wastewater which is not contaminated by the process, such as boiler blowdown, cooling water, sanitary sewage, or storm water from outside the immediate manufacturing area, is not included in the definition of process wastewater.

Status of Pesticide Intermediates

The manufacture of pesticide intermediates is not within the scope of this study. As noted in Section XIX, Glossary, the definition of "manufacturer of pesticide intermediates" adopted is . . . the manufacture of materials resulting from each reaction step in the creation of pesticide active ingredients, except for the final synthesis step, and are, in most cases, nonconventional pollutants. In the pesticide industry these intermediates may be purchased from other manufacturers, produced on-site in the exact quantities required for pesticide production, or produced on-site in excess of that required. It is due to these factors, and the fact that these intermediates are common to many other chemical processes, that they were not included in this proposal. However, there are several instances in which available data relate to comingled streams from intermediate and active ingredient production, and these are presented with the appropriate footnote in this proposal.

Effect of Previous Regulations

Final BPT regulations for direct dischargers in the Pesticide Chemicals Industry were published in the Federal Register on April 25, 1978, and were amended on September 29, 1978. The effects of these regulations on the current study are as follows:

1. Several pesticides and classes of pesticides (such as triazines) were excluded from the BPT regulations. Therefore, this study addresses nonconventional pesticide pollutant and priority pollutant removal technology for both direct and indirect dischargers, as well as BOD, COD, TSS, and pH for direct dischargers (see Section XXI—Appendix 2 for a list of previously excluded pesticides).

2. Forty-nine pesticide parent compounds were specifically identified in the BPT regulation for direct dischargers as having EPA promulgated analytical methods available for the pesticide parameter. COD, BOD, TSS, and pH were also regulated for these compounds. Therefore this study addresses the priority pollutants for direct and indirect dischargers which potentially are present in any of these pesticides (see Section XXI--Appendix 2 for a list of these 49 pesticides), and addresses pesticides for indirect dischargers. There are exceptions to the above discussion for 7 of the 49 previously regulated pesticides. Aldrin, dieldrin, DDT, DDD, and DDE do not require coverage under this regulation because discharge of wastewater from the manufacture and/or formulation of these pesticides was prohibited by Section 307(a) of the Clean Water Act published in the Federal Register, January 12, 1977 (U.S. EPA, 1977h). The pesticide parameter for endrin and toxaphene established acceptable levels for direct discharges (see January 12, 1977

Federal Register). Wastewaters from endrin and toxaphene will be subject to BAT/PSES regulations for associated priority pollutants (direct and indirect discharge) and endrin and toxaphene parameters (indirect discharge).

3. All pesticides not identified in Items 1 and 2 above were regulated during BPT for the direct discharge of BOD, COD, TSS, and pH. Therefore this study addresses the nonconventional pollutant pesticides and priority pollutants for products in this group being directly or indirectly discharged.

4. The metallo-organic pesticides with mercury, cadmium, copper, or arsenic bases were assigned a zero-discharge limitation during BPT for direct dischargers. Process wastewater from these metallo-organic pesticides will be subject to PSES and PSNS regulations for indirect discharge for nonconventional and priority pollutants and NSPS regulations for new direct discharge facilities.

5. Formulators/packagers of pesticide active ingredients that discharge wastewater to navigable waters were assigned a zero-discharge status for BPT. This study addresses formulators/packagers that discharge process wastewater to POTWs which are subject to PSES and PSNS regulations and new direct discharge formulator/packagers which are subject to NSPS regulation.

Analytical Methods and Detection Limits

Since analytical procedures for pollutants covered under this study were not uniformly available, EPA developed analytical methods for priority pollutants and manufactured pesticides at selected plants within the industry. Sampling was conducted at 16 such facilities, and the resulting data are presented in this report. In July 1978 the Effluent Guidelines Division of EPA determined that the continued use of Gas Chromatography/Mass Spectrometry (GC/MS) may pose an inordinate economic burden upon manufacturers who might be required to purchase and/or perform monitoring with this expensive analytical instrument. Instead, it was proposed that the more readily available and economic Gas Chromatograph (GC) be used to qualitatively and quantitatively define the levels of priority pollutants in industrial wastewaters. High pressure liquid chromatography (HPLC) was considered an equivalent alternative to GC methods. A summary of the methods developed by the EPA contractors for this report is presented in Section XXI--Appendix 4. Priority pollutant and nonconventional pesticide analytical methods developed by industry were requested during the months of March through July 1982 and will be available for review as part of the administrative record. The Agency intends to propose industry analytical methods in 40 CFR Part 455 in January 1983.

Both priority pollutants and manufactured pesticide methods are undergoing separate development and review at the Environmental

Monitoring and Support Laboratory (EMSL) in Cincinnati, Ohio. Priority pollutant methods were proposed in the Federal Register in December 1979 and are scheduled for promulgation in the near future; numerous pesticide methods are under EPA 304(h) committee review.

A summary of all available pesticide analytical methods from such sources as the 1973 Federal Register, EPA/EMSL, EPA contractors, industry, literature, and others is given in Appendix 8 of Section XXI. In part, this list forms the basis for the subsequent selection of pesticides to be regulated for the nonconventional pesticide parameter based on analytical methods availability. Methods for residue analysis, required for pesticide registration by the Federal Insecticide, Fungicide, and Rodenticide Act, are available in the administrative record.

Detection limits were considered in two major ways in this study. First, during sampling and analysis programs, a level of interest was established for specific pollutants. This level of interest defined the detection limits to which quantitative results were sought, but below which values were acceptably reported as "not detected." The levels of interest used in this study are defined in Section XIX. Second, in the selection of effluent limitations and pretreatment standards in Section XV, the published detection limits for each pollutant regulated were compared on an individual plant basis to the level required by the effluent limitations. In cases where the detection limit was insufficient to meet effluent limitations, either the limitation was revised or in-plant monitoring of segregated streams was recommended.

Wastewater Sampling and Data Acquisition

This study evaluates existing data and information gathered during a screening sampling program conducted by EPA regions and private contractors. A verification sampling program was then conducted by four EPA contractors to accurately define the source and level of pollutants in pesticide wastewaters. Following verification sampling, an industry self-sampling program was instituted which is still in progress. Data obtained from the above-mentioned programs and additional priority pollutant and nonconventional pesticide data received directly from manufacturers as a result of 308 surveys are presented in this report. The adequacy and applicability of these data have been evaluated by the Effluent Guidelines Division of EPA.

Economic Impact

This document is a technology-based assessment of the Pesticide Chemicals Industry. The broader economic effects which might result from the required application of recommended technologies were assessed in a separate document prepared by EPA/Office of Analysis and Evaluation which is available as part of the pesticides rulemaking package. This impact analysis was based on a plant-by-plant evaluation of the type and cost of recommended technologies, if any, needed to meet the proposed

limitations included in this document. The results of this evaluation are presented in Sections XII and XIV.

Water Quality

The frequency of occurrence and maximum level of concentration for conventional, nonconventional, and priority pollutants in the pesticide industry is presented in Section IX and compared to known human health and ecological effects and proposed EPA water quality criteria. In this manner water quality was one of several factors considered to be within the scope of this study in recommending whether pollutants be considered of primary, dual, or secondary significance.

The environmental effects of implementing the proposed standards and limitations which are presented in Section II, including the effects on aquatic life, were assessed in separate documents prepared by EPA/Monitoring and Data Support Division (Versar, Inc., contractor).

METHODOLOGY

A brief description of the methodology used in the conduct of this study is given below for the purpose of gaining an overview of project accomplishments from February 1978 through August 1982, and to provide a better understanding of the organization and logic of this report.

Definition of the Industry

The first task upon commencing this project was to accurately define the pesticide products which would be covered, given the assumptions described above in "Scope of Study." A list of pesticides potentially manufactured was developed from the following sources:

1. Existing records from the BPT study;
2. Listing of pesticide facilities made available through the EPA/Office of Pesticides Programs;
3. 1977 Directory of Chemical Producers, Stanford Research Institute;
4. Pesticides Process Encyclopedia, Marshall Sittig, 1967;
5. Source Assessment: Prioritization of Stationary Water Pollution Sources, U.S. EPA, 1977 (List of 108 Environmentally Significant Pesticides); and
6. 1977 Chemical Economics Handbook--Pesticides, Stanford Research Institute.

As a result of this initial review, a total of 167 potential manufacturers were identified.

308 Survey

A 308 Survey was drafted by EPA and reviewed and approved by the Effluent Guidelines Subcommittee of the National Agricultural Chemicals Association (NACA). After approval was obtained from the Office of Management and Budget (OMB #158-R0160), the survey was distributed in July 1978. The purpose of this survey was to obtain basic data concerning manufacturing, disposal, and treatment, as well as to identify potential sources of priority pollutants. A copy of the survey is provided in Section XXI--Appendix 5. For those plants previously contacted during BPT, a review of the records was made and many of the basic data were not requested a second time. Instead, specific questions concerning the conventional and nonconventional pollutants were asked along with the general priority pollutant portion of the survey. Responses were received during August, September, and October 1978. Based on the assumptions in the scope of coverage, 117 plants were selected for further study. After evaluation of the survey responses, it was necessary to send approximately 90 additional 308 follow-up letters during the months of March, April, and May 1979 to clarify the record on each plant as well as to request specific priority pollutant data and treatability studies which might have been available. During the months of March and April 1980 it was again necessary to send 308 follow-up letters to over 50 selected plants requesting specific data points to be used primarily for statistical analysis. It is anticipated that additional 308 surveys will be required between proposal and promulgation.

Existing Data Evaluation

A major source of data for this study was the approximately 60,000-page record which was developed in support of the BPT regulation. These files contain extensive plant process, treatment, and economic data, in addition to NPDES permits discharge monitoring reports and literature. These data were summarized and incorporated into a work plan for the conduct of this study. Additional data have been incorporated into these files throughout the course of this review.

Screening Sampling

A screening, sampling, and analysis program was conducted during 1977 and 1978. Screening sampling was the first step in determining the source and level of priority pollutants in the pesticides industry. A total of 30 plants were screened--27 by EPA Regional Sampling and Analysis teams and the remainder by private contractors. These samples were taken and analyzed by GC/MS for the 129 priority pollutants using the March 1977 protocol prepared by EMSL-Cincinnati (U.S. EPA, 1977g). These data were used to assist in the selection of plants for verification sampling and in the identification of specific pollutants to be analyzed at those plants. Since GC was the proposed method of analysis used to define levels of priority pollutants for the pesticide industry, the levels reported from GC/MS analysis performed during screening sampling were not utilized in calculating individual plant effluent

averages. A summary of screening sample results is presented in Section XXI--Appendix 6.

Verification Sampling Program

An evaluation of existing data as well as 308 Survey responses was used to select 16 plants for the verification program in the pesticide industry according to the following criteria: if process chemistry analysis or screening sampling indicated that priority pollutants existed or were likely to be present in the raw waste or treated effluent; if the plant employed a potential BAT wastewater treatment technology; and if the plant manufactured a variety of pesticide types.

Due to the time constraints involved in the study, a total of four contractors performed sampling and analysis at the plants selected. The following procedures were employed at each of the individual plants:

1. An engineering visit was scheduled and conducted. At this visit a comprehensive engineering survey of the plant was made, historical data were reviewed, potential priority pollutant sources were identified, and grab samples were taken of at least the process intake water, raw process wastewater, and treated effluent. These samples were transferred to the individual contractor laboratories for the purpose of developing a specific GC method for each priority pollutant and each manufactured pesticide suspected to be present in the plant wastewater. An additional grab sample was taken before and after the major treatment process for transmittal to a separate contractor working for EMSL-Cincinnati who was to develop methods only for the manufactured pesticides. An engineering report was filed and provided to plant personnel for review and comment.

2. A sampling plan was prepared which, upon conclusion of laboratory efforts to determine analytical methods, provided the rationale for selection of future sampling sites and parameters along with a step-by-step analytical procedure for each of the pollutants to be measured. A copy of this report was provided to the plant in advance of any further wastewater sampling.

3. A verification sampling visit was scheduled and conducted, consisting of one grab sample and three 24-hour composites taken at each site specified in the sampling plan. Teams of engineers and technicians took samples, preserved them, and shipped them to contractor laboratories for analysis of conventional, nonconventional, and priority pollutants. The grab samples were analyzed first to ensure that the proposed methods were applicable. In addition, a large-volume sample was taken before and after the major treatment process for transmittal to a second EMSL contractor

who was charged with developing precision and accuracy data for the manufactured pesticide parameter. In some cases plant personnel also collected wastewater from EPA sampling sites or were provided split samples by the EPA contractor during verification sampling visits. When plant analyses were provided this information was incorporated into the data base for this report.

4. A verification sampling report was filed on completion of laboratory analysis. A copy of this report was provided to the plants for review and comment. The report contained results of analyses, documentation of problems encountered, and evaluation of treatment system performance. The results of the verification sampling program are summarized in Appendix 6--Section XXI.

5. A final plant report was prepared for each site visited to include all the above-mentioned material, plant correspondence, sampling logs, and final analytical procedures utilized. These reports were also provided to the individual plants for comment.

6. A laboratory data report was prepared for each plant including individual chromatograms, laboratory notebooks, and documentation of all quality control measures employed. GC/MS procedures were used to confirm GC analysis, when specific problems existed, for approximately 10 percent of the verification samples. Due to the volume of these reports, only one copy was made and forwarded to EPA; the originals are maintained with each individual contractor.

Industry Self-Sampling Program

EPA is soliciting volunteers for self-sampling and self-analysis programs to be conducted for 30- to 45-day periods at specific plant/process waste streams. The purpose of the program is to obtain a statistically valid quantity of data on selected priority pollutants, and to incorporate those data into a Final Regulation.

The recommendation for the selection of plants to undergo self-sampling/self-analysis was based on a review of the adequacy of plant data, the presence of detected or likely to be present priority pollutants proposed for regulation, and whether potential BAT technology was currently in place. From this review nine plants were recommended for the self-sampling program. To date, four plants have participated in the program.

Data from each of the volunteer plants has been received, processed, and evaluated. Raw waste and treated effluent waste loads have been statistically analyzed, and an evaluation of the treatment system performance was made.

Quality Assurance/Quality Control

The entire verification program was designed to be conducted in accordance with a written sampling protocol (ESE, 1979) and within specific analytical Quality Assurance/Quality Control (QA/QC) guidelines (Jayanty, 1979). The sampling protocol specified methods of container preparation, sample fractioning and preserving, sample transportation, and sample documentation and tracking.

The analytical QA/QC program was set up and implemented by a separate contractor. The elements of this program were:

1. Preparation of a QA/QC manual which consolidated and supplemented in-house manuals by each of the analytical contractors.

2. Establishment of quality control goals for duplicate and spike analyses; in this case all first-day verification samples were duplicated, and all third-day samples were spiked and recoveries calculated.

3. Implementation of quality assurance testing for each analytical laboratory. Each contractor was forwarded unidentified concentrations (both high and low) containing compounds common to two of the plants analyzed by the lab. These samples, prepared in distilled water, were analyzed utilizing the same procedures used on actual plant wastewaters. In addition, one sample with identical constituents was sent to all of the analytical contractors for a comparative basis. The results of these analyses were returned to the QA/QC contractor for comparison with levels pre-determined by gravimetric measurement. The results of the QA/QC program are available in a series of reports in the administrative record.

The precision and accuracy goals of the study were: an overall accuracy of ±25 percent, including sampling, extraction, and GC measurement; and spike recovery equal to or greater than 70 percent.

Audit of Actual Wastewater Analytical Data

After evaluating the results of the QA/QC program, it was decided that an audit of portions of the actual wastewater analytical data supplied by the verification analysis contractors would be appropriate. At least 10 percent of the data from each of the four verification contractors was audited by the QA/QC contractor. Since the audit revealed some deviations from protocol, an additional audit took place of the remaining 90 percent of the data for the pollutant parameters which were under consideration for recommended regulation. The results of the above-mentioned audits were incorporated into the data tables found in this report.

Process Chemistry Evaluation

Because there are 117 plants in the industry and only 16 were sampled during the verification program, it was imperative to undertake an evaluation of each of the other pesticide processes not sampled in order to determine which priority pollutants were likely to be present for the industry as a whole. This review was accomplished using the process flow diagrams which were provided to EPA by each plant as part of the 308 Survey response as well as using existing BPT and other technical information. EPA determined that pollutants are likely to be present if they are the final manufactured product, used as raw materials, or are commonly known or reported by-products or impurities of the reaction. All of the pollutants identified as likely to be present by this approach were compared to known data and confirmed. The results of the process chemistry evaluation of 280 pesticides, of which 32 are currently not manufactured, are presented in Section V.

Raw Waste Load Summary

All available raw waste load data were gathered and presented in conjunction with the process chemistry evaluation. Historical data from BPT, screening data, verification data, 308 data, and plant monitoring and treatability data were all consolidated and summarized in Section V according to groups of priority pollutants as defined in the Glossary, Section XIX.

Treatment Technology Evaluation

Treatment and control technology currently available within the industry and transfer technology from other industries were evaluated in terms of their applicability to the pesticide industry. Control and treatment technologies routinely accomplishing exemplary removal (achieving effluent limitations and standards) of specific pollutants in other industrial categories were evaluated to determine whether they would be applicable to the pesticide industry if treatment data were absent or treatment performance judged inadequate as compared with other available performance data in the pesticide industry. EPA has determined that treatment and control technology from other industrial categories can be transferred to the pesticide industry because regardless of the origin of the wastewater, these certain technologies are routinely effective in removing specific pollutants. Specifically, technologies were transferred from the electroplating and organic chemicals industries for removal of metals, cyanide, and volatiles. The theory of each technology, full-scale design and operating data, and treatability data are all discussed in Section VI. These technologies were analyzed in terms of their effectiveness for removing each individual or group of priority pollutants and nonconventional pollutant pesticides. Based on this review, flow diagrams are presented for the individual treatment technology units recommended, along with the design and operating efficiency criteria.

Subcategorization

Factors such as raw materials, wastewater treatability, prior regulatory status, wastewater characteristics, disposal, manufacturing processes, plant location, age, and size were all considered prior to arriving at a recommended subcategorization. Based on these criteria, 280 individual pesticides in the industry were grouped according to the type of treatment units required to remove the conventional, nonconventional, and priority pollutants in their wastewaters. A further discussion of subcategorization is given in Section VII.

Cost and Energy

As shown in Section VIII, cost curves for each of the recommended treatment units are presented. The unit treatment costs were then combined in a building-block approach according to subcategory requirements, where capital, annual, and energy costs were itemized. Because treatment units were designed and costed for maximum pollutant concentrations, many plants may require lower levels of removal. Additional data will often be required before this determination can be made.

Nonwater Quality Impact

The potential air and solid waste effects of recommended treatment are discussed in Section VIII in a qualitative manner, and quantitatively where data permit.

Selection of Pollutant Parameters

The selection of pollutant parameters proposed to be regulated was based on the availability of technical data and on evaluations of raw waste load presence and concentration, treatability, analytical methods availability, and environmental and health effects. Accordingly, pollutants were designated primary, dual, or secondary in significance. Section IX provides a more complete explanation for the selection of pollutant parameters.

Selection of Expanded Best Practicable Technology

Pesticides excluded from the BPT regulations are proposed for regulation under expanded BPT for BOD, COD, TSS, and pH pollutant parameters. As discussed in Section X, the technology on which the expanded BPT proposed limitations are based is equal to that which formed the basis of the BPT regulation.

BCT

In Section XI the three BAT treatment technology options were utilized to perform a preliminary BCT cost test. The purpose of this test is to show whether the cost to reach recommended BAT levels is reasonable when compared to the cost a POTW would require to achieve similar effluent levels. On July 28, 1981, the Fourth Circuit Court of Appeals remanded

the regulations establishing this BCT methodology and directed the Agency to conduct an additional cost-effectiveness test and to correct data errors. The Agency has corrected data errors and applied a second cost-effectiveness test. The revised BCT methodology was proposed in the Federal Register on October 29, 1982.

Selection of Best Available Technology

Proposed effluent limitations have been established by EPA based on such factors as prior pesticide regulatory status, method of disposal, and analytical methods availability, as well as the development of effluent variability factors, the economic effect of implementing proposed effluent limits, and treated effluent data for each subcategory.

The pollutants proposed to be regulated are presented in Section XII. The factors considered in making this decision were prior regulatory status, method of disposal, analytical methods availability, and significance in the industry.

Based on technical feasibility and actual performance data, four levels of treatment were initially considered. The design effluents for each level of treatment were then determined. An evaluation of the economic and technical aspects of implementing regulations at the design effluents led to the selection of one level of treatment as Best Available Technology.

A plant-by-plant treatment cost analysis was prepared to determine the requirements and costs for each plant to comply with the proposed effluent long-term averages. Treatment costs were estimated for those nonconventional pesticides and priority pollutants proposed for regulation. The results of this analysis, as presented in Section XII, were provided to the EPA economic contractor so the potential impact of treatment costs on plant production could be calculated.

Selection of NSPS Technology

NSPS is based on consideration of process modifications, in-plant controls, and end-of-pipe technology, as defined in Section XIII. The pollutants proposed for NSPS regulation are presented in this section. Three treatment technology options and associated costs were considered for this regulation.

Selection of Pretreatment Standards Technology

Pretreatment standards are based on consideration of effluents achievable by plants utilizing recommended technologies, other than biological oxidation.

The pollutants proposed for regulation are presented in Section XIV. The factors considered in making this decision were prior regulatory status, method of disposal, analytical methods availability, and significance in the industry.

Based on technical feasibility and actual performance data, two levels of treatment were initially considered. The appropriate design effluents for two levels of treatment were then determined. An evaluation of the economic and technical aspects of implementing regulations at the design effluents led to the selection of one level of treatment for pretreatment standards for new and existing sources.

A plant-by-plant treatment cost analysis was prepared to determine the requirements and costs for each plant to comply with the selected effluent long-term averages. Treatment costs were estimated for those nonconventional pesticides and priority pollutants proposed for regulation. The results of this analysis, as presented in Section XIV, were provided to the EPA economic contractor so the potential impact of treatment costs on plant production could be calculated.

Selection of BAT and NSPS Effluent Limitations and Pretreatment Standards for Existing (PSES) and New Sources (PSNS)

Pollutant long-term averages were determined by considering both effluent levels currently being achieved and effluents estimated to be achievable based on recommended technology. Effluent levels currently being achieved in the pesticide industry are presented in Section XV for each pollutant proposed for regulation. An evaluation is also presented in Section XV of the effluents estimated to be achievable for nonconventional pollutant pesticides and priority pollutants proposed to be be regulated. The technical basis for the selected long-term averages is established in this portion of Section XV. The method of calculating the proposed effluent long-term averages for direct and indirect dischargers is presented for pollutants proposed for regulation.

Available priority pollutant and pesticide data were statistically analyzed to determine variability in the daily and monthly effluent levels. From these results, which are presented in Section XV, the daily and 30-day maximum effluent limitations and pretreatment standards for each regulated pollutant were calculated, such that they can be achieved by well-operated plants a high proportion of the time.

Environmental Assessment

As discussed in Section XVI, an assessment of the environmental effects of implementing the proposed standards and limitations is presented in a separate document prepared by EPA/Monitoring and Data Support Division. This assessment projects the significance of post-regulatory discharges of nonconventional pesticides and priority pollutants on human health, aquatic life, and the operation of POTWs.

Appendices

Appendices XXI-1 through XXI-9 are provided to list important reference data too lengthy for the body of the report and data that are helpful in interpreting the report.

SECTION IV

INDUSTRY PROFILE

ECONOMIC AND INVENTORY DATA

It is important to understand the structure of the Pesticide Chemicals Industry before any conclusions can be drawn concerning the proper approach to the drafting of regulations, the effectiveness of alternative pollution control technologies, the feasibility of wastewater monitoring, or the financial ability of plants to install pollution control equipment. This section presents economic and inventory data so that decisions can be made with full knowledge of their limitations and advantages as relates to this complex industry.

Each individual pesticide manufacturing process differs, however structural similarities are normally used to classify pesticides in groups containing halogens, phosphorus, nitrogen, or metals. Since these processes are proprietary, detailed process descriptions cannot be presented in this document. Generalized descriptions were presented by Jett (1978) based on structural grouping of pesticides.

In addition to pesticide manufacturers there are plants which formulate and package pesticide active ingredients. Most formulator/packagers generate little or no wastewater and have comparatively uncomplicated batch-blending systems. Formulator/packager information is presented as a subsection to this section.

Pesticide Utilization

The major classes of pesticides are presented in Table IV-1. The total 1977 production volume for reported pesticides within the scope of this study was approximately 1.6 billion pounds according to the Industry 308 Survey. Although published data on industry output lag as much as three to four years, it is estimated that this production volume accounts for more than 95 percent of the compounds of interest. A 1980 article (Chemical Week, May 7, 1980) estimates pesticide shipments of 1.7 billion pounds in 1978. The relative percentage of production for pesticide classes is consistent with prior data; however, a trend toward increasing volumes of insecticide and decreasing volumes of herbicide production is indicated. The number of products within each class of pesticides conforms roughly to the volume produced for each class. With regard to the general toxicity of each class, the decreasing order would be insecticides, herbicides, and fungicides, although there are usually exceptions in each category. There is not necessarily a correlation between toxicity and the presence of priority pollutants.

As reported by Eichers, et al. (1978), the total pesticide use for farm and nonfarm purposes in 1976 was estimated at 1.67 billion pounds. Farmers used an estimated 661 million pounds of all pesticides, a 38 percent increase over 1971. In 1976 a total of 394 million pounds of herbicides was applied by farmers, an increase of 76 percent over 1971. The leading crop herbicides used by farmers in 1976 were atrazine (90 million pounds) and alachlor (89 million pounds). In 1976, 162 million pounds of insecticides were used on 74.9 million acres of major field crops, hay, pasture, and rangeland. The organochlorine insecticides accounted for 60 percent of all farm crop insecticides in 1966, 46 percent in 1971, and 29 percent in 1976. The increased use in 1976 of organophosphate and carbamate insecticides helped to reduce the organochlorine residue problems but has increased potential hazards to farm workers. Although there has been a shift away from organochlorines, toxaphene was the leading insecticide used in 1976, at 30.7 million pounds. The major fungicides used in 1976 were chlorothalonil and copper compounds. Approximately 43.2 million pounds (4.1 pounds per acre) of fungicides were applied in 1976. The overall growth rate of pesticide use between 1971 and 1976 was 40 percent. The volume of exports was 621 million pounds (36 percent of industry total) in 1978, and exports are expected to reach 43 percent by 1990 (Chemical Week, May 7, 1980).

The primary factors behind the 1976/1977 growth from previous years are increased pesticide usage by farmers, particularly cotton and soybeans, and increased foreign demand for domestic pesticides (NACA, 1978). Pesticide shipments are expected to increase by 7 percent per year, while costs are predicted to rise 6 percent per year through 1990 (Chemical Week, May 7, 1980).

Structural Grouping of Pesticides

It is sometimes productive to examine pesticides in terms of their functional groups. Similarities in molecular weight, polarity, and solubility may be found in pesticides with the same structure. These similarities may translate into pollutant generation or treatability homogeneity. For example, hydrolysis treatment under the proper pH and temperature conditions is effective for certain triazine compounds because they possess a similarly bound chloride ion which can be displaced by an hydroxyl ion, thereby changing the nature of the compound to a hydroxytriazine. Even groups of pesticides produced by like processes do not necessarily generate the same priority pollutants; however, for purposes of discussion it is often convenient to classify them by structure as shown in Table IV-2. Further identification of chemical structure and configuration for typical and major pesticides can be found in the U.S. Environmental Protection Agency Pesticide Chemicals Development Document (Jett, 1978). Pesticides within the scope of this study are defined by structural groups in the Glossary, Section XIX.

Geographical Location of Plants

Figure IV-1 presents the geographical location of the 117 pesticide manufacturers under consideration in this study. Since a majority of pesticides are produced at the same sites as other organic chemicals, plant location is governed by considerations such as proximity to raw materials, ease and cost of transportation, local labor and tax conditions, and other factors which would affect any plant siting. Less than half the manufacturers formulate their products on-site; instead they ship to formulators/packagers located near the areas of farm consumption.

Market Value of Pesticides

The response to the Industry 308 Survey revealed that the 1977 market value for pesticides produced in the scope of this study ranged from 2.5 to 3 billion dollars. Pesticide sales in 1978 were estimated to range from 2.2 to 3.0 billion dollars (Chemical Week, May 7, 1980).

An examination of individual plant and total industry market value ranges shows two major trends which must be considered in any technical or economic evaluation of the industry. First, as shown in Figure IV-2, almost half of the plants produced products with an annual market value of less than 5 million dollars for all pesticides produced. This indicates that these plants must be examined closely if large capital expenditures are to be required for pollution control facilities. Second, over 50 percent of the total industry market value is attributed to only 14 plants. These plants have the ability to finance larger pollution control investments as well as to maintain staffs capable of engineering, operating, and monitoring the control systems. The significance of this concentration of plants at the extremes of market value must be further evaluated in terms of pollutant generation potential and technology requirements before any final conclusions can be drawn concerning economic impact of this regulation.

Level of Pesticide Production

Figure IV-3 shows, even more dramatically than market value ranges, that the distribution of individual pesticide production capacities is skewed toward the low end of the scale. In 1977, 117 pesticide plants made 248 discrete pesticides from a total of 322 pesticide process sites. Of the 322 process sites more than 44 percent of the pesticides considered were produced at levels less than 10,000 pounds per day, indicating the specialized nature and low demand for certain products. Again, it should be noted that there is a group of 14 to 18 products with high-volume, heavy-usage patterns such as some cotton insecticides or selective post-emergence herbicides. The extremes of production indicate a need for individual plant evaluation of the economic impact of this regulation.

Figure IV-4 shows the annual level of pesticide production for the 305 process sites reporting. More than half the processes produce less than 1 million pounds of pesticide per year.

Number of Pesticides Produced Per Plant

Figure IV-5 demonstrates the highly individual nature of each pesticide plant and the narrow product base from which business is conducted. For example, approximately 95 percent of the plants produce no more than four pesticides, while almost 50 percent produce only one. When plants are found to produce more than one pesticide the products are usually derived from similar reaction chemistry, thereby allowing the same unit process configurations to be used with minor changes in raw materials. Although several plants are shown to produce more than four pesticides during any one year, it is uncommon for plants to run more than four to five process lines simultaneously.

Number of Days Each Pesticide Produced

The frequency of pesticide production shown in Figure IV-6 follows the same pattern of extremes as other plant operational factors. In this case, approximately 20 percent of all reported pesticides were produced less than 30 days per year, while another 20 percent were produced for all 12 months of the year. This figure indicates the seasonal nature of the majority of pesticides production, along with the few exceptions of continuous production for a group of high- to medium-volume products.

Number of Plants Producing Pesticides

Figure IV-7 demonstrates the effect of patents on the operating structure of the industry. Approximately 84 percent of all patented pesticides are only produced by individual plants, whereas after patent expiration each of the remaining 16 percent is produced at from two to four different plants. These facts contribute to the difficulty of examining and comparing wastewater data among identical products. As a matter of fact, there are several cases where the same product is made by a different process by different plants, thereby resulting in different pollutants, treatment technology required, and economic impact.

Number of Plants Owned by Companies

As demonstrated in Figure IV-8, approximately 72 percent of all companies own only one pesticide manufacturing plant. Of the remaining 28 percent, 13 companies own two plants each, four companies own four plants each, and four separate companies own three, five, six, and seven plants, respectively. The above illustrates that pesticide plant ownership is generally not concentrated among a few companies. However, it should be noted that certain companies may be the sole producer of a pesticide sub-group. For example, under the metallo-organic structural group the pesticides identified as organo-tins are currently manufactured by only one plant.

Other Operations at Pesticide Plants

Another complicating factor in obtaining and evaluating data from pesticide facilities is that very few sites produce only pesticide active ingredients. Response to the Industry 308 Survey presented in Table IV-3 shows that 57 percent of the plants produce pesticide intermediates. More than 74.4 percent of the pesticide plants also produce other miscellaneous chemicals. There are only seven pesticide plants producing neither intermediates nor other chemicals, thereby representing less than 6 percent of the industry. More than 90 percent of all plants have at least one shared treatment system for pesticide intermediate and miscellaneous chemicals wastewaters.

Methods of Wastewater Disposal

Table IV-4 itemizes the methods of wastewater disposal utilized at pesticide plants. Many plants have more than one method of disposal, as there are a total of 142 discrete methods utilized at 117 plants. The thrust of this report is toward those plants discharging to navigable waters (42 plants), those discharging indirectly to POTWs (37 plants), and those achieving zero discharge because no wastewater is generated (9 plants), because of evaporation ponds (6 plants), and because of incineration without scrubber effluent (1 plant). Plants also utilize deep well injection (18 plants), contract hauling of all wastewater (9 plants), land disposal (3 plants), and ocean discharge (1 plant).

Type of Wastewater Treatment

Tables IV-5 and IV-6 have been provided to identify the more than 26 different types of treatment used by direct dischargers and by plants discharging indirectly to POTWs, etc. It should be noted that more than one means of disposal may be used by each of the 117 plants.

There are 42 plants that dispose of wastewater by direct discharge to navigable waters. Physical/chemical treatment with activated carbon, resin adsorption, hydrolysis, chemical oxidation, steam stripping, or metals separation is used by 22 direct dischargers. Further explanation of the design and operation of these treatment units is provided in Section VI. There are 26 discrete plants included in Table IV-5 that use biological treatment for direct discharge of pesticide wastewater. Biological systems may consist of an aerated lagoon, activated sludge unit, or trickling filters. Post-biological or tertiary treatment consisting of multimedia filtration or activated carbon is used by four direct dischargers.

There are 37 discrete manufacturers included in Table IV-6 discharging to a municipal treatment system, of which seven plants treat pesticide wastewater by activated carbon, resin adsorption, hydrolysis, chemical oxidation, or steam stripping. More than 20 percent of the POTW dischargers do not treat at least one pesticide waste stream.

Formulator/Packagers

In addition to the plants which manufacture active ingredients there are plants which make pesticide products by formulating, blending, canning, and packaging operations. In formulating and packaging the raw materials used are the pesticide active ingredients, which may be procured from outside suppliers or may be manufactured on site. The processing types in this subcategory (called formulators and packagers) are mechanical and physical/chemical in nature. The levels of wastewater generation and contamination are either considerably lower than in the active-ingredient production or are sometimes nonexistent. Pesticide formulations and packaged products generally fall into three classifications: water-based, solvent-based, and dry-based. Types of formulations include powders, dusts, wettable powders, emulsifiable concentrations, granules, and aerosols. There are approximately 5,000 formulation plants registered with the Agency.

The scale on which pesticides are produced covers a broad range. Undoubtedly, many of the small firms, having only one product registration, produce only a few hundred pounds of formulated pesticides each year. At least one plant that operated in the range of 100,000,000 pounds of formulated product per year has been identified. The bulk of pesticide formulations, however, is apparently produced by independent formulators operating in the 20,000,000 pounds to 40,000,000 pounds per year range. Table IV-7 provides an estimate of the production distribution of formulating/packaging facilities. It is suggested, however, that nonmanufacturing formulator/packager distribution will be more skewed toward small production. The average range of wastewater flows for formulator/packagers is estimated to be between 50 gallons to 5,000 gallons per day.

The relative proportion of pesticide classes produced by formulator/packagers is presented in Table IV-8. Liquid formulations account for approximately 70 percent of total formulations, whereas solid formulated pesticides are approximately 30 percent. Pesticide formulators are generally smaller than manufacturers, having an average of 32 workers, 18 of whom are employed in production (Sittig, 1980).

The data collected to support the initial regulation show that approximately 90 percent of the formulators/packagers surveyed do not generate any process wastewater. The remaining plants generate low volumes of highly concentrated wastewater when they wash out reaction vessels or control their air emissions by using air scrubbers. These plants typically evaporate these wastes or contract haul them to meet the BPT zero discharge limit.

Additional technical and economic data have been collected for this portion of the industry subsequent to promulgation of the BPT regulation. The Agency assumes that formulator/packagers conduct the same operations regardless of mode of discharge.

Metallo-Organic Pesticide Manufacturers

The general group of metallo-organic pesticides includes products with metallic bases such as mercury, cadmium, copper, arsenic, tin, iron, manganese, zinc, etc. Direct discharge metallo-organic manufacturers of mercury, cadmium, copper, and arsenic-based pesticides were regulated under BPT as a class separate from all other manufactured pesticide products. Therefore, for purposes of consistency these regulations (PSES, PSNS, and NSPS), which will apply to the metallo-organic manufacturers, will also cover mercury, cadmium, copper, and arsenic-based products as a separate class. Other pesticides which are tin, iron, manganese, or zinc-based are classified with all other manufactured pesticides in this study. Certain pesticides may use one of the above-mentioned metals as a catalyst in their process; however, the definition of metallo-organic pesticides used in this study is. . . a class of organic pesticides containing one or more metal or metalloid atoms in the pesticide chemical structure.

In the manufacturing process for metallo-organic pesticides, the principal sources of wastewater are: byproduct stripping, product washing, caustic scrubbing, tank and reactor clean-out, and area washdowns. Adequate information is available concerning the wastewater characteristics associated with these operations for the mercury, cadmium, copper, and arsenic-based pesticides. However, a continuing effort is underway to better characterize the waste streams resulting from the manufacture of these compounds. Based on available information, it is understood that the current state-of-the-art is such that no discharge of process wastewater pollutants is being achieved through the application of recycle technology for these pesticides. The installation of additional technology is not anticipated at facilities where these metallo-organic pesticide chemicals are manufactured.

Table IV-1. Pesticide Production by Class

Class	Number of Products	Production Volume (1977) Million lbs	Percent
Insecticide*	87	846	51.74
Herbicide	77	554	33.88
Fungicide†	71	229	14.01
Rodenticide	5	2	0.12
Plant Growth Regulator	1	4	0.25
TOTAL	241**	1,635††	100

* Includes miticides, nematicides, repellants, insect synergists, fumigants, insect growth regulators, insecticides.

† Includes algicides, bactericides, molluscicides.

** Seven additional pesticides are currently manufactured, but their classification is unknown at this time.

†† Production not available from 30 (9.3 percent) of 322 process sites.

Table IV-2. Structural Grouping of Pesticides

Structural Grouping of Pesticides	Number of Pesticides in Group
Aldrin-Toxaphene	7
Amides	9
Amide type	4
Botanicals	5
Carbamates	15
Chlorinated Aryloxyalkanoic Acids and Esters	15
Cyanates	3
DDT type	7
Dioxin type	1
Halogenated Aliphatics	10
Halogenated Aromatics	23
Heterocyclic with Nitrogen in the Ring	20
Metallo-Organic*	14
Nitro	13
Nonhalogenated aliphatics	1
Nonhalogenated aromatics	8
Nonhalogenated Cyclic Aliphatics	1
Organo Nitrogen-Others	17
Organo Sulfur	5
Phosphates and Phosphonates	5
Phosphorothioates and Phosphorodithioates	36
Phosphorus-Nitrogen	6
Thiocarbamates	14
Triazines	14
Uracils	2
Ureas	11
Noncategorized Pesticides	14
TOTAL	280

* Does not include mercury, copper, cadmium, and arsenic-based products.

Table IV-3. Types of Operations at Pesticide Plants (1977)

Type of Operation	Number of Plants	Percent of Total
Manufacturer of Pesticide Active Ingredients	117	100
Manufacturer of Other Miscellaneous Chemicals	87	74.4
Manufacturer of Pesticide Intermediates	67	57.3
Formulator/Packager of Pesticides	55	47.0

Table IV-4. Methods of Wastewater Disposal at Pesticide Plants (1977)

Type of Wastewater Disposal	Number of Plants*
Direct Discharge to Navigable Waters	42
Indirect Discharge (POTW, etc.)	37
Deep Well Injection	18
Incineration	13
No Wastewater Generated†	9
Contract Hauling of all Wastewater	9
Evaporation Ponds	6
Land Disposal	3
Ocean Discharge	1

* There are a total of 117 plants in the industry; however, many have more than one means of disposal.

† Includes wastewater which is recycled, reused, or because no wastewater is generated.

Table IV-5. Treatment Utilized at Plants Disposing Pesticide Wastewaters to Navigable Waters

Type of Wastewater Treatment	Number of Plants*
Activated Carbon	16†
Activated Sludge	13
Aerated Lagoon	16
Anaerobic Digestor	1
API-Type Separator	1
Chemical Oxidation	6
Chlorination	3
Coagulation	4
Equalization	30
Evaporation Pond	2
Flocculation	3
Gravity Separation	28
Hydrolysis	5
Metal Separation	1
Multimedia Filtration	5**
Neutralization	31
None	2
Not Available	1
Pressure Leaf Filter	2
Resin Adsorption	2
Skimming	8
Sludge Thickening	1
Stripping	1
Trickling Filters	3
Vacuum Filtration	2
Wet Scrubber	5

* There are a total of 42 plants disposing to navigable waters; some use more than one type of wastewater treatment.

† Activated carbon used as tertiary treatment in three waste streams.

** Multimedia filtration used as tertiary treatment in three waste streams.

Table IV-6. Treatment Utilized at Plants Disposing Pesticide Wastewaters to POTWs

Type of Wastewater Treatment	Number of Plants*
Activated Carbon	2
Activated Sludge	3
Aerated Lagoon	2
Chemical Oxidation	2
Chlorination	3
Coagulation	2
Crystallization	1
Equalization	11
Evaporation Pond	1
Flocculation	2
Gravity Separation	14
Hydrolysis	1
Multieffect Evaporation	1
Multimedia Filtration	2
Neutralization	24
None	5
Not Available	1
Resin Adsorption	2
Skimming	6
Sludge Thickening	1
Stripping	3
Vacuum Filtration	2
Wet Scrubber	1

* There are a total of 37 plants disposing to POTWs; some use more than one type of wastewater treatment.

Table IV-7. Formulator/Packager Production Distribution

Production (million lbs/yr)	Percent Formulator/Packagers
≤0.5	24
>0.5 to ≤5.0	41
>5.0 to ≤50	35
TOTAL	100

Table IV-8. Percent of Formulator/Packager Pesticide Classes

Class	Percentage
Herbicides	40.0
Insecticides	32.0
Fungicides	19.4
Fumigants	8.6
TOTAL	100

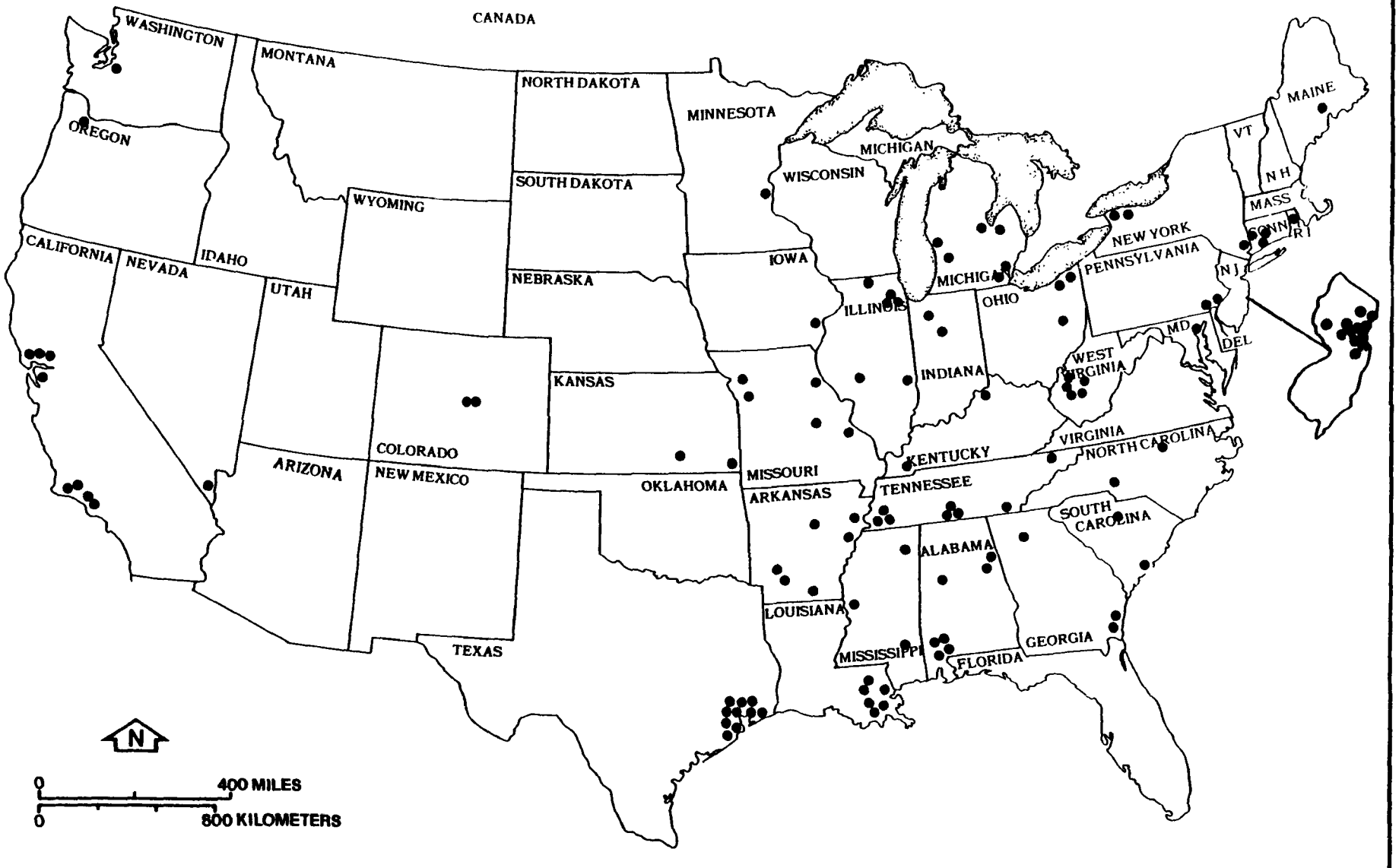
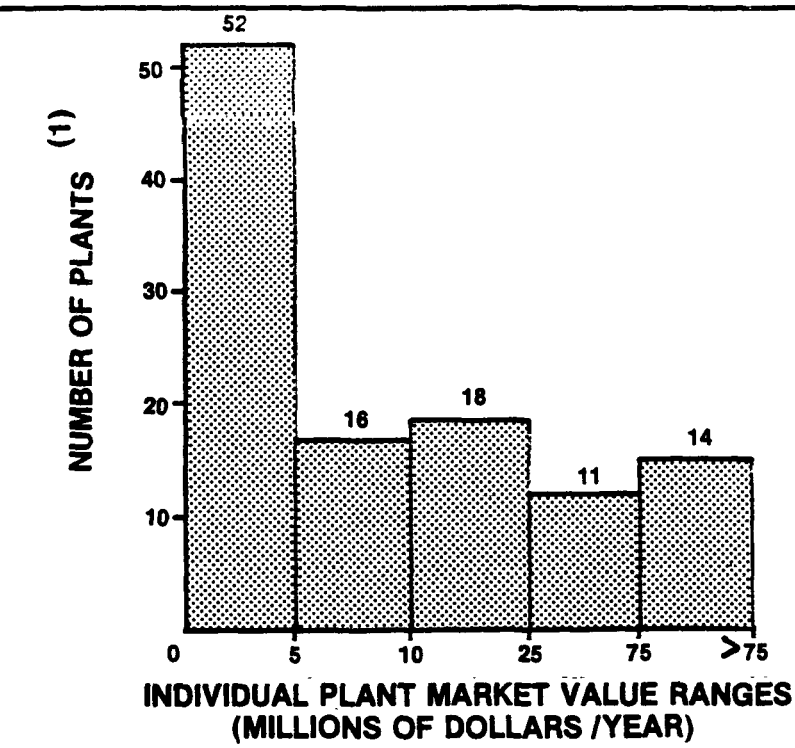
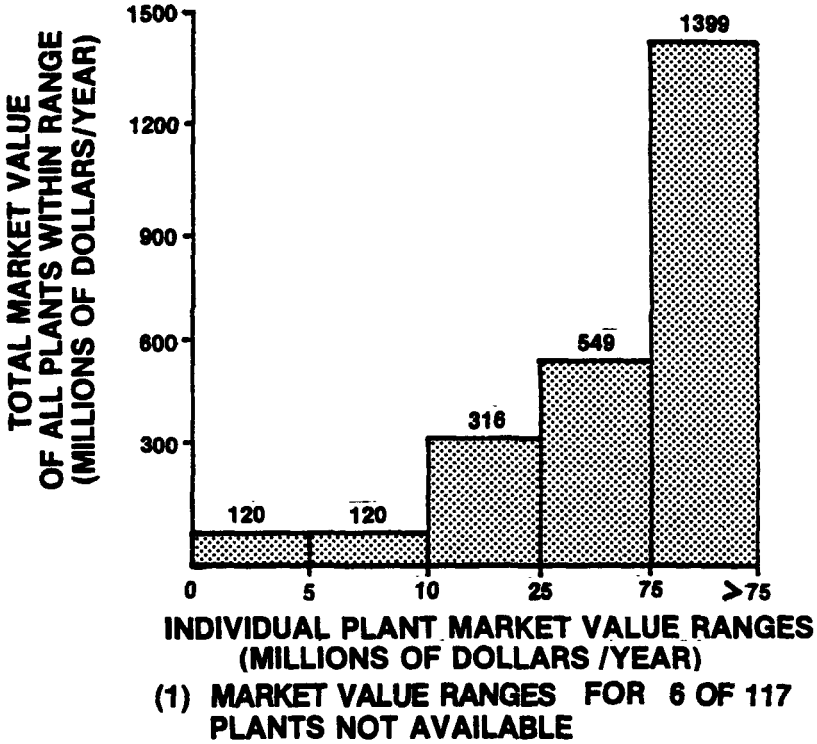


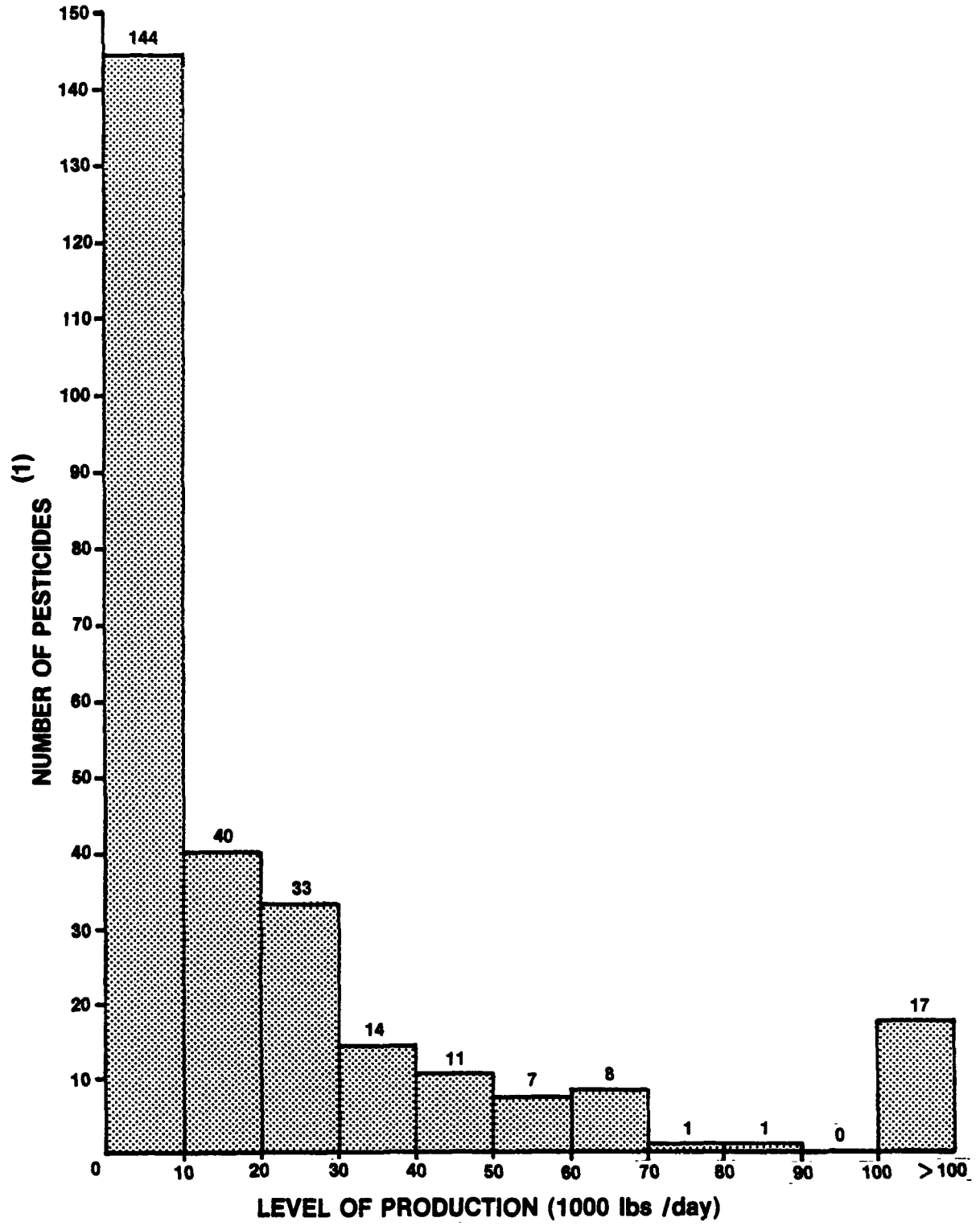
Figure IV-I GEOGRAPHICAL LOCATION OF PESTICIDE MANUFACTURERS (TOTAL OF 117 PLANTS)





(1) MARKET VALUE RANGES FOR 6 OF 117 PLANTS NOT AVAILABLE

FIGURE IV-2. MARKET VALUE OF PESTICIDES (1977)



(1) LEVEL NOT AVAILABLE FOR 45 (14%) OF 322 PROCESS SITES

FIGURE IV-3 DAILY LEVEL OF PESTICIDE PRODUCTION (1977)

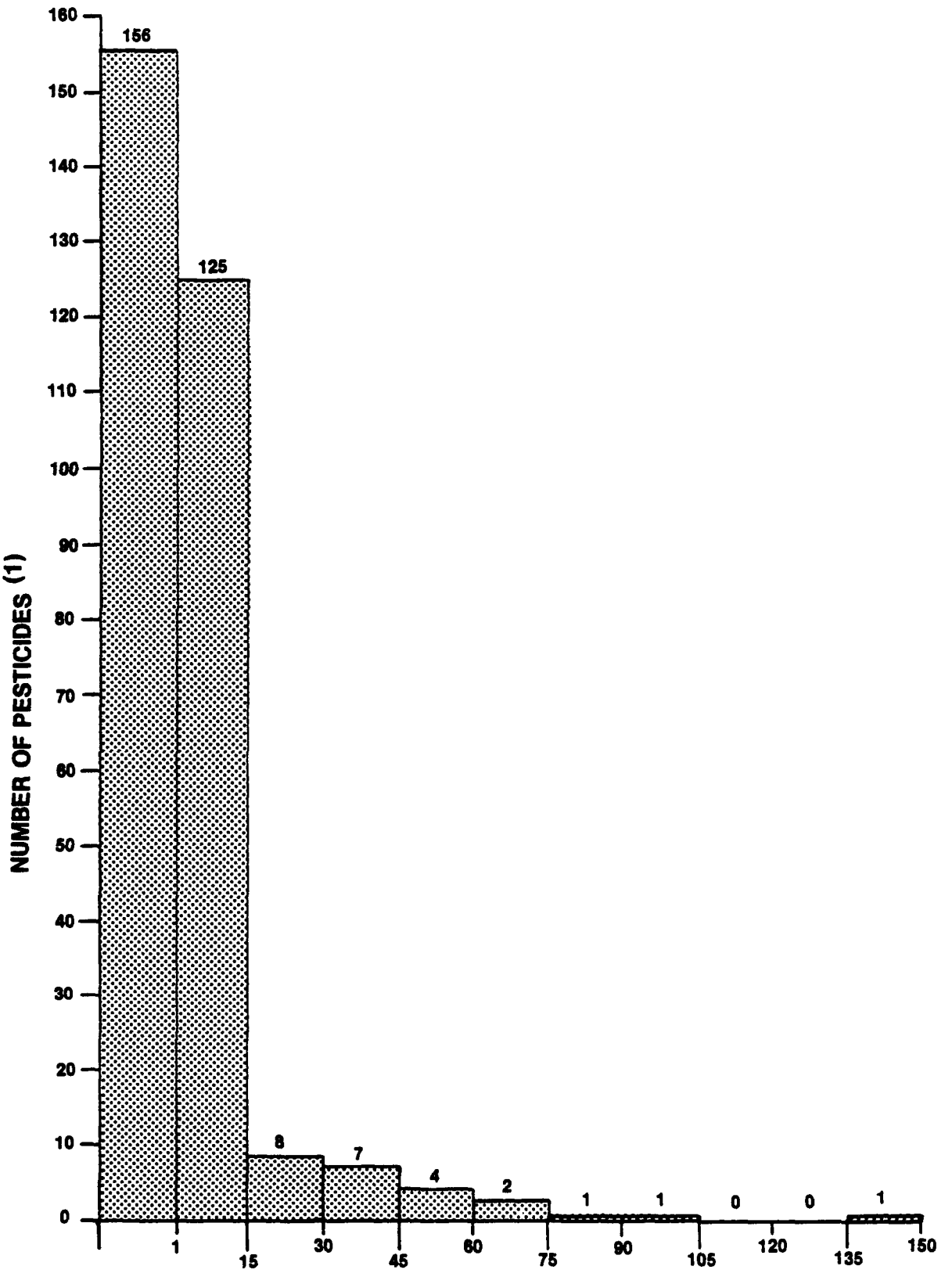


Figure IV-4 ANNUAL LEVEL OF PESTICIDE PRODUCTION (1977)

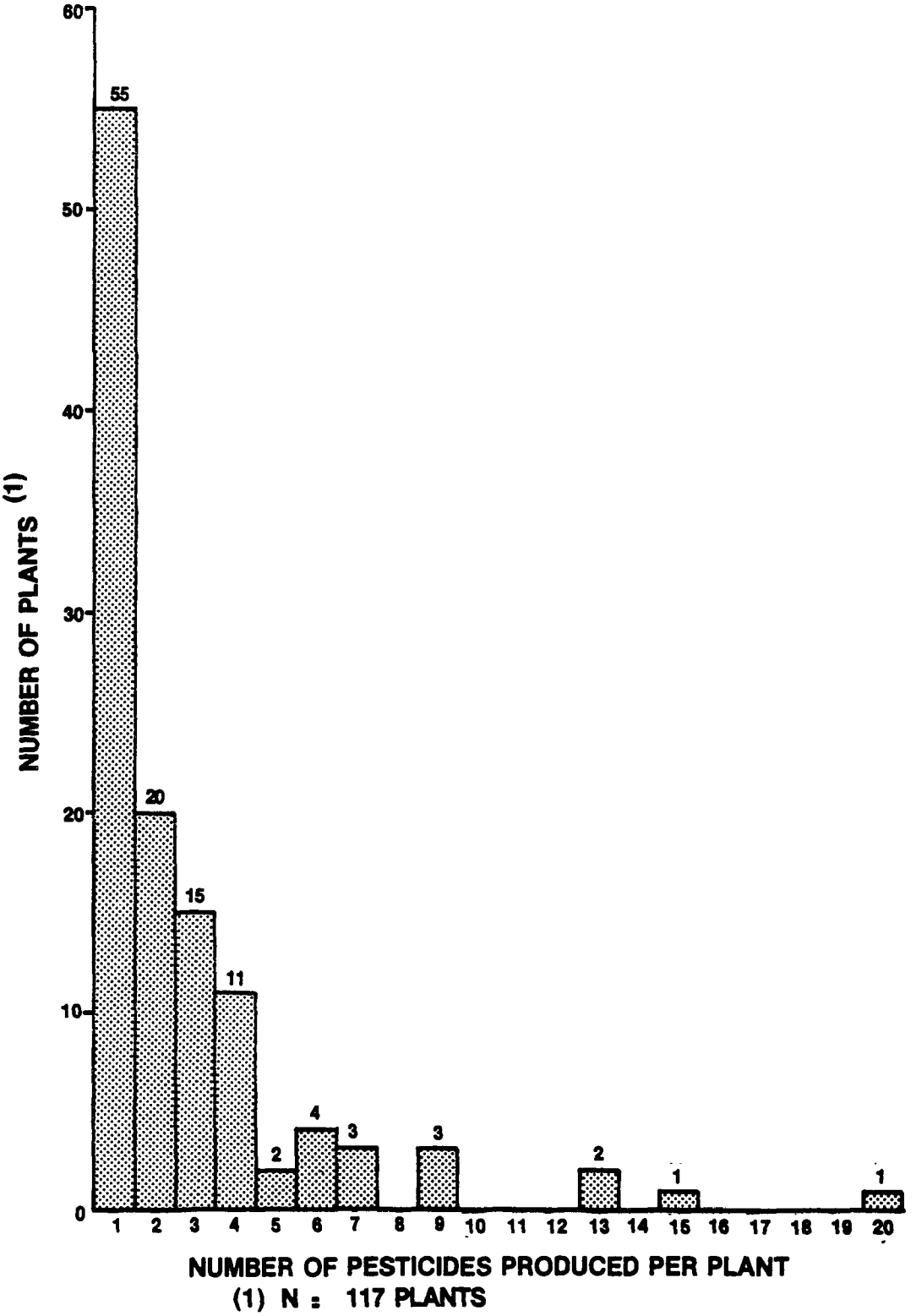
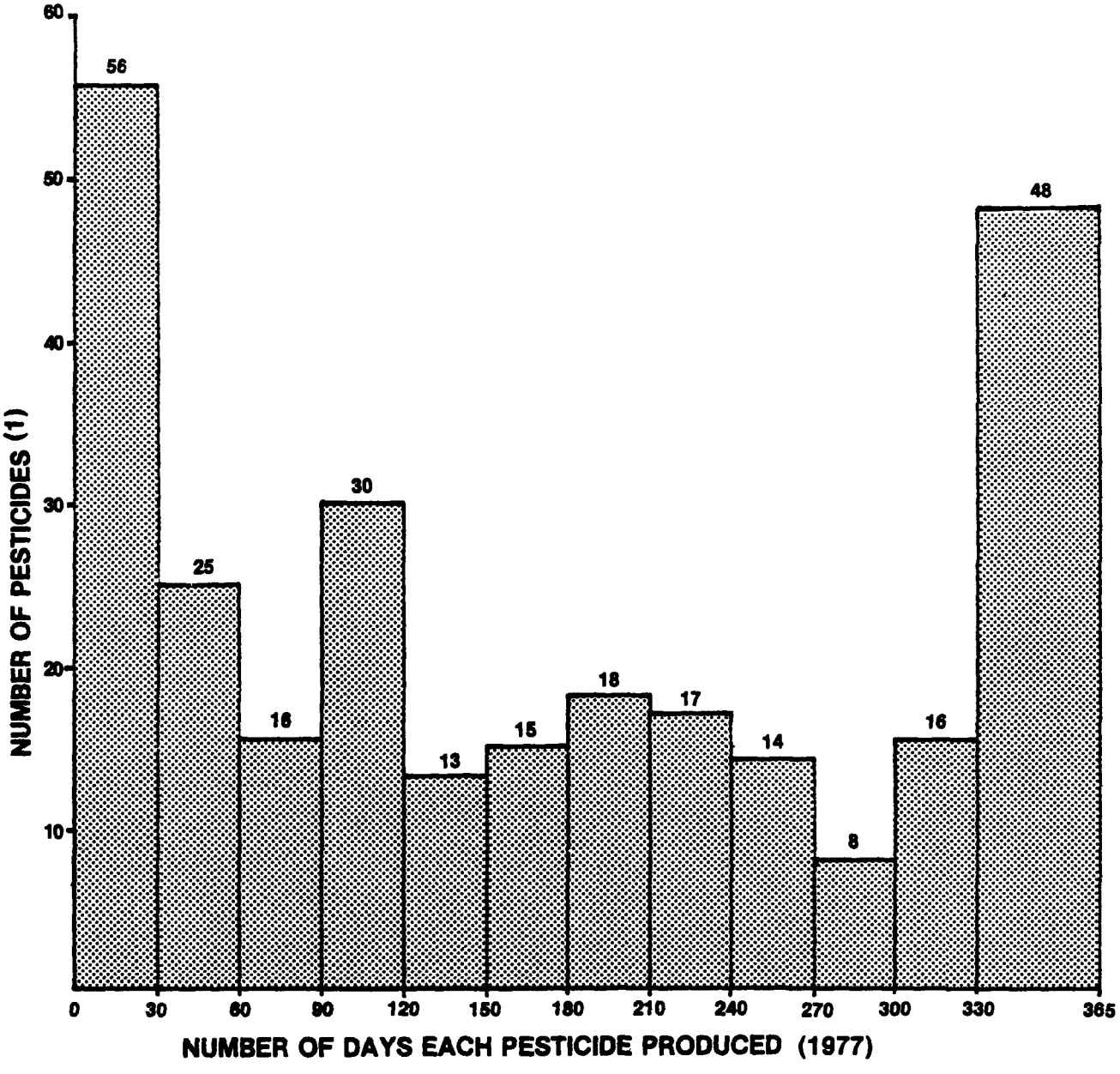


FIGURE IV-5 NUMBER OF PESTICIDES PRODUCED PER PLANT (1977)



(1) FREQUENCY NOT AVAILABLE FOR 46 (14.3%) OF 322 PROCESS SITES

FIGURE IV-6 FREQUENCY OF PESTICIDE PRODUCTION (1977)

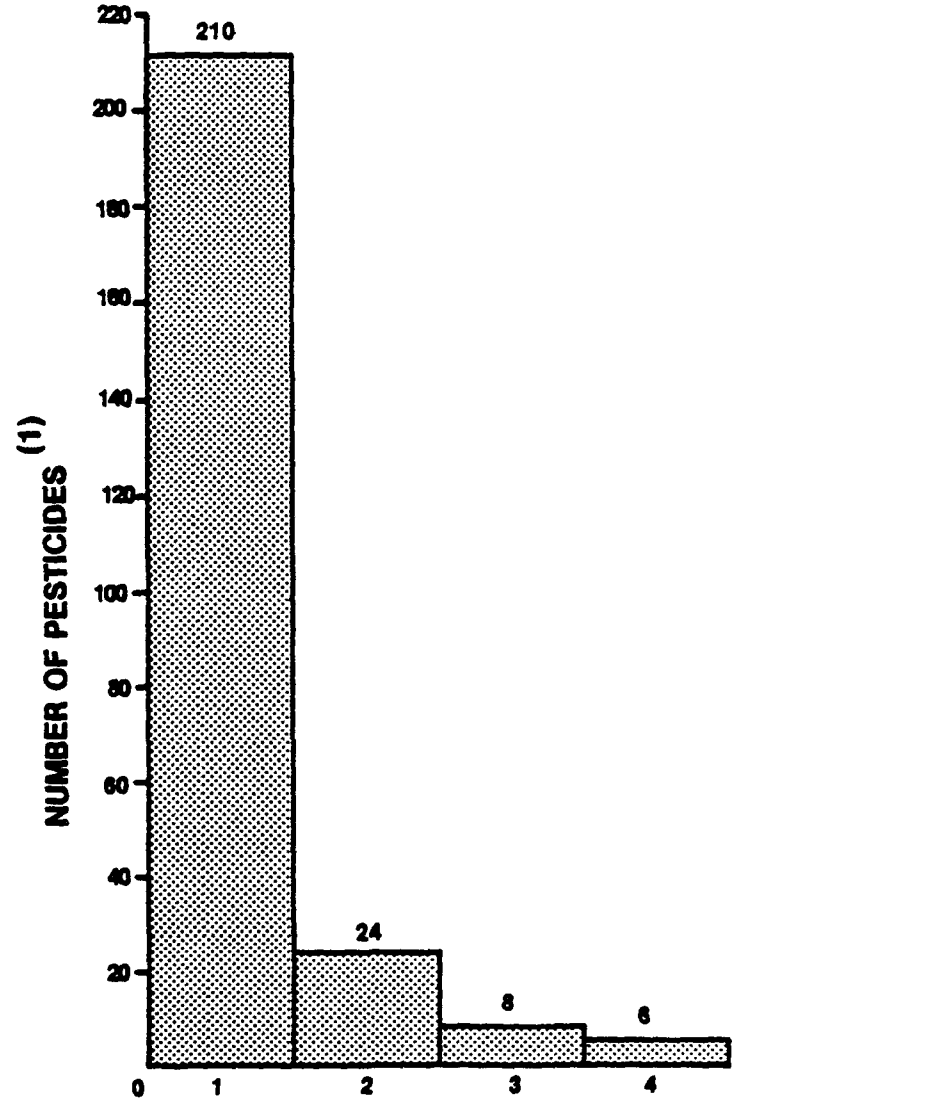


FIGURE IV-7 NUMBER OF PLANTS EACH PRODUCING THE SAME PESTICIDE (1977)

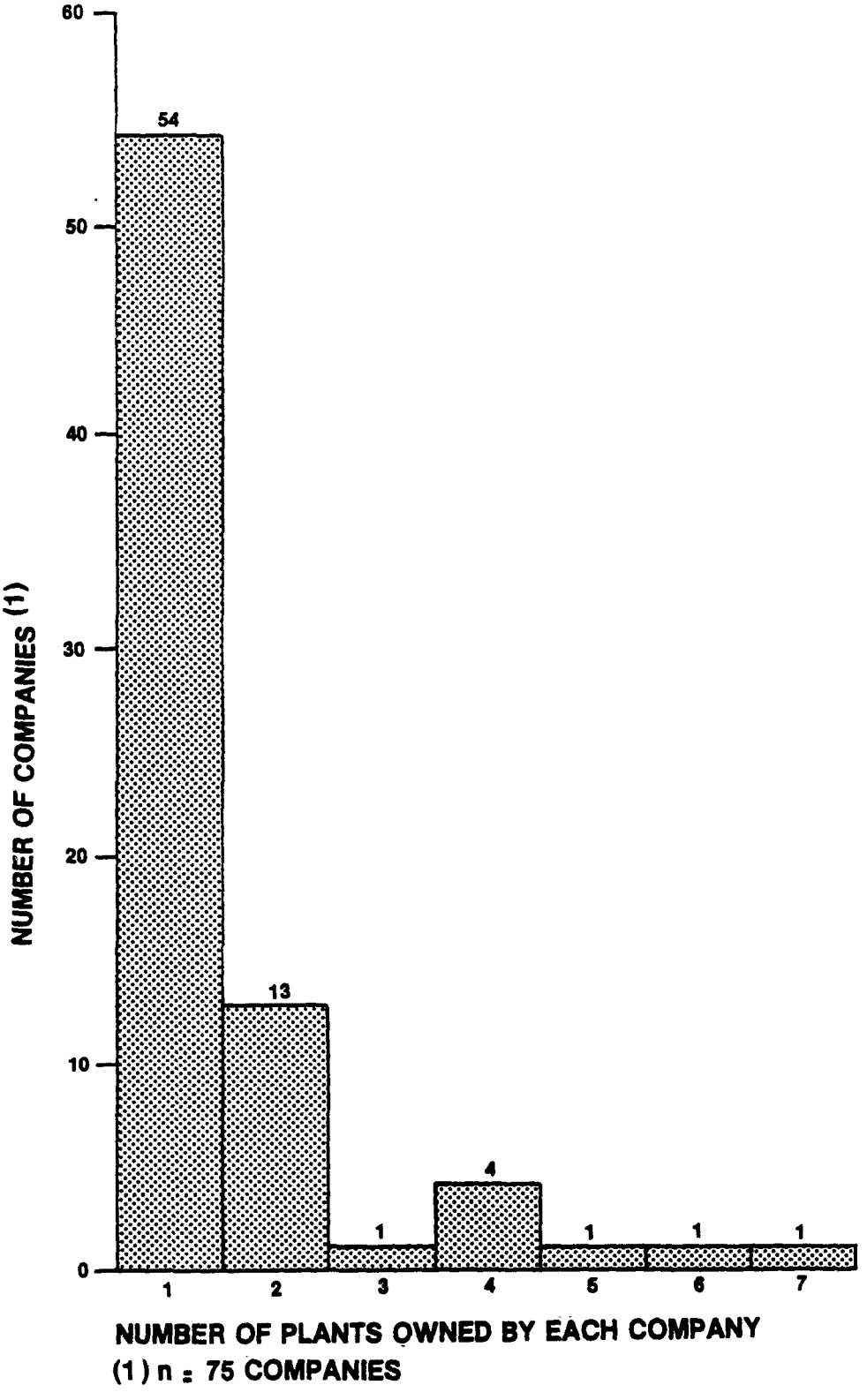


Figure IV-8 NUMBER OF PLANTS OWNED BY EACH COMPANY (1977)

SECTION V

RAW WASTE LOAD CHARACTERIZATION

The purpose of this section is to define the raw waste load flow and wastewater characteristics for the 280 pesticides covered under this study in terms of priority pollutant, conventional, and nonconventional parameters. The term "raw waste load," as utilized in this document, is defined as the quantity of flow or pollutant in wastewater prior to a treatment process. Raw waste load flow is normally expressed in terms of million gallons per day (MGD), or gallons of wastewater per 1,000 pounds of pesticide production (gal/1,000 lbs). Raw waste load characteristics are normally expressed in milligrams per liter (mg/l) or pounds of pollutant per 1,000 pounds of pesticide production (lbs/1,000 lbs).

In order to assess the pollutant potential for the industry as a whole, it was necessary to approach the task from two directions: first, all available raw waste load data were collected from the BPT study, from manufacturers' responses to the 308 Survey and subsequent follow-up letters, from screening sampling, and from the verification sampling program conducted at 16 plants; second, a process chemistry evaluation of each pesticide was conducted in order to determine which pollutants were likely to be present. In this manner the theoretical (priority pollutants likely to be present based upon a process chemistry evaluation) and the measured (detected) presence of priority pollutants could be documented.

The flow, concentration, and mass per unit of production were calculated for each pollutant at each plant where data were available. The most productive method of evaluating the pollutant concentration data was according to groups of priority pollutants which were similar in chemical/physical characteristics and in method of laboratory analysis (see Section XIX--Glossary, and Section XXI--Appendix 1, for identification of specific compounds within each priority pollutant group which are included in the scope of this study).

Priority pollutants likely to be present were defined by conducting a process chemistry evaluation for each pesticide process. The possible sources of the pollutants were identified as: raw materials used in pesticide synthesis, impurities in raw materials, byproducts of synthesis reactions, solvents used as a carrier medium, solvents used as an extraction medium, impurities in solvents, catalysts, manufactured products, or other sources. This process chemistry evaluation was conducted by examining proprietary process diagrams supplied by manufacturers, by reviewing supplemental literature on each process, and by analyzing process conditions (pH, temperature, reaction time, etc.) and raw materials specifications where available.

The detected and likely presence of pollutants derived in this manner is presented in Tables V-1 through V-34. These data are also utilized in later sections of this report to help establish subcategorization, to provide a basis for design and costing of recommended treatment systems, and to provide a basis for the selection of priority pollutant parameters to be regulated.

There is an ongoing effort by EPA to acquire additional data. All recommendations and proposals in this report are based on existing information; however, any supplemental data incorporated at a future time may affect the results presented herein.

FLOW

The process wastewater flow for each pesticide was evaluated to determine the amount of flow per unit of pesticide production (gal/1,000 lbs) and the amount of flow (MGD) from all pesticides produced at individual plants.

Figure V-1 presents a probability plot of the flow ratio (gal/1,000 lbs) for 269 of the 322 pesticide process sites from which data were available. Significant information in this figure shows that: 11 percent of all pesticides have no flow; 50 percent of all pesticides have flows equal to or less than 1,000 gal/1,000 lbs; and 84 percent (approximately one standard deviation above the median) have flows equal to or less than 4,500 gal/1,000 lbs. Later in this section the 4,500 gal/1,000 lbs will be utilized as the design flow for the industry.

Figure V-2 presents a probability plot of pesticide flows (MGD) at individual plants. This figure shows that 50 percent of all plants have flows less than 0.01 MGD, and that virtually all plants (98 percent) have flows less than 1.0 MGD. In Section VIII of this report treatment cost estimates will be based on the range of flows from 0.01 to 1.0 MGD.

Flow reported in the tables of this section represent the flow measured at the given sample point rather than pesticide process flow or total plant flow (see tables listing pollutants detected in pesticide process wastewaters).

PRIORITY POLLUTANTS

An overview of the frequency of detected or likely to be present priority pollutant groups is presented in Table V-1. These data show that even the most prevalent pollutant group, volatile aromatics, is likely to be present in only approximately 40 percent of the 280 pesticides in the scope of study.

A specific discussion of the significance of each priority pollutant in relation to this industry is provided in Section IX. The source and raw waste load level of pollutants are presented by pollutant group below.

Volatile Aromatics

Benzene and its derivatives are used widely throughout the chemical industry as solvents and raw materials. Table V-2 illustrates the indicated presence of these compounds in the pesticide industry. Mono-, di-, and tri-chlorobenzenes are used directly as pesticides for their insecticidal and fungicidal properties. Benzene, toluene, and chlorobenzene are used as raw materials in the synthesis of at least 14 pesticides, although their main use is as a carrier solvent in over 78 processes. It is understandable that the remaining aromatics and chlorinated aromatics existing as impurities or reaction byproducts are easily possible due to the rearrangement of the basic raw material and solvent compounds.

Table V-3 shows that volatile aromatics have been detected in three pesticide wastewaters in concentrations greater than 1,000 mg/l. Approximately one-fourth of the pesticides wastewaters for which data exist contained concentrations greater than 100 mg/l.

Halomethanes

Table V-4 shows that methylene chloride, chloroform, and carbon tetrachloride (di-, tri-, and tetra-chloromethane, respectively) are used mainly as raw material and extraction solvents in approximately 28 pesticide processes. Bromomethanes can be expected in at least three pesticides as reaction byproducts and can function as a fumigant, in the case of Pesticide J2.

Table V-5 shows that halomethanes are known to exist at levels greater than 100 mg/l in 4 of the 25 pesticides sampled. Methylene chloride has been detected at concentrations as great as 31,000 mg/l.

Cyanides

The pollutant cyanide is detected or likely to be present in approximately 25 pesticide processes, as shown in Table V-6. The primary raw materials which favor cyanide generation are cyanamides, cyanates, thiocyanates, and cyanuric chloride. The latter compound is exclusively used in the manufacture of triazine pesticides.

Verification sampling at four pesticide plants identified cyanide levels ranging from not detected to 5.04 mg/l, as shown in Table V-7, except for Pesticide F1 with wastewater containing 5,503 mg/l.

Haloethers

There are seven compounds classified as priority pollutants that contain an ether moiety and halogen atoms attached to the aryl or alkyl groups. Table V-8 identifies 30 pesticides which indicate the presence of at least one compound from this class. Bis(2-chloroethyl) ether (BCEE) is used as a raw material in Pesticides D1 and V1, while BCEE itself,

dichloroethyl ether, functions as a fungicide or bactericide in certain applications. In the remainder of the pesticides listed in Table V-8 the ethers are indicated to be present as impurities or reaction byproducts from such common pathways as the Williamson synthesis or the dehydration of an alcohol.

Only BCEE has been identified in pesticide wastewaters. Table V-9 shows that the product R1 contains 0.582 mg/l of BCEE which was generated as a result of impurities in butylcarbitol chloride raw materials. Nondetectable levels of other halogenated ethers have also been reported. No other plant or verification data are currently available for this group of pollutants.

Phenols

Phenols are compounds having the hydroxyl (OH) group attached directly to an aromatic ring. The phenolic compounds under consideration in this study are derivatives of phenol, in particular chlorophenols, nitrophenols, and methylphenols (cresols). These compounds may be found throughout the pesticide industry as raw materials, impurities in raw materials, or as byproducts of reactions utilizing related compounds such as chlorobenzenes, etc. It can be concluded from Table V-10 that the use of 2,4-dichlorophenol as a raw material will tend to generate variously substituted chlorophenols in process wastewaters. The presence of pentachlorophenol (PCP) will almost always be restricted to the production of the pesticide itself, except for the possible overchlorination of benzene in the presence of caustic in mono-, di-, tri-, and hexachlorobenzene. The presence of nitrated phenols is expected in the pesticides M1, N1, W1, and X1. Methylated phenols are not expected to be found in significant concentrations since they are not used as raw materials, but they may appear as impurities or byproducts of reaction from Pesticides O1 and R1 due to the use of such raw materials as 4-methylthio-m-cresol and 4-chloro-2-methylphenol, respectively.

From an examination of Table V-11 it can be seen that chlorinated phenols are detected in concentrations greater than 1,000 mg/l in at least three pesticide wastewaters and have been found at concentrations as high as 42,000 mg/l. Nitrophenols have been detected up to 461 mg/l, while no data are available for methyl phenols.

Nitro-Substituted Aromatics

As shown in Table V-12, none of the three priority pollutant nitro-substituted aromatics are indicated to be present as raw materials in pesticide processes. Nitrobenzene is produced for commercial use in soaps, shoe polish, and as a chemical intermediate, while the dinitrotoluenes are important intermediates in the production of explosives such as trinitrotoluene (TNT). Approximately 27 pesticides with nitroaromatic structures have been identified which could contain one of these three priority pollutants as an impurity or a reaction

byproduct due to rearrangement or substitution on the parent aromatic compound.

As shown in Table V-13, only two pesticide processes have been monitored for the presence of nitro-substituted aromatics with reported concentrations of not detected and less than 0.01 mg/l. The remaining 25 processes for which the presence of nitro-substituted aromatics are likely to be present have not been monitored.

Polynuclear Aromatics

There are 17 priority pollutant compounds which can be classified as polynuclear aromatics (PNAs). These compounds consist of two or more benzene rings which share a pair of carbon atoms. They are all derived from coal tar, with naphthalene being the single largest constituent. Naphthalene derivatives such as alpha-naphthylamine and alpha-naphthol are used in a number of pesticide processes; therefore, naphthalene and 2-chloronaphthalene should be by far the most prevalent PNA priority pollutants in the industry. As shown in Table V-14 acenaphthene, acenaphthylene, anthracene, fluorence, fluoranthene, and phenanthrene should be found only as raw material impurities. The remaining ten polynuclear aromatic compounds are not indicated to be present in pesticide processes.

As shown in Table V-15, naphthalene has been detected in Pesticides S1 and T1 at 0.066 mg/l. Naphthalene and 2-chloronaphthalene have been detected in Pesticide H1 at 1.06 mg/l and less than 0.01 mg/l, respectively. No other polynuclear aromatics have been detected.

Metals

In the pesticide industry metals are used principally as catalysts or as raw materials which are incorporated into the active ingredient, e.g., metallo-organic pesticides. As shown in Table V-16 copper may be found or is likely to be present in wastewaters from at least 11 pesticides where it is used as a raw material or catalyst, but is not incorporated into the active ingredient. Of the remaining priority pollutant metals, only zinc becomes part of the technical grade pesticide as in U1, V1, T1, K1, Q1, R1, and S1. Manganese and tin-based pesticides are still manufactured; however, these are not priority pollutant metals.

Priority pollutant metals below the level of interest, defined in Table V-17, may be expected in any pesticide process due to several factors:

1. Chromium, copper, nickel, and zinc are used extensively in stainless steel and/or other fabrication metal alloys;

2. Machinery bearings often contain as much as 5 percent antimony, cadmium, or lead in addition to the other metals present (copper, nickel, and zinc);

3. Antimony and arsenic are often found as hardening agents in copper, lead, and other metals or metal alloys;

4. Cadmium and lead are used in fusible alloys and some solders;

5. Corrosion-resistant tank linings and piping often use lead, nickel, and zinc;

6. Arsenic is combined in nature with phosphorous and therefore may enter the plant as a raw material impurity;

7. Cadmium may be an impurity in lime;

8. Chromium is added to noncontact cooling water streams to inhibit slime formation; and

9. Any compound may be found in plant intake water. It is, however, unlikely that thallium, silver, beryllium, or selenium will be found in significant levels in any wastewaters.

As displayed in Table V-17, copper exists in levels of 59,000 mg/l and 5,350 mg/l in Pesticides G1 and M1, respectively. Zinc has been identified in Pesticides T1 and U1 at 247 mg/l.

Chlorinated Ethanes and Ethylenes

The chlorinated ethanes and ethylenes are used as solvents, cleaning agents, and intermediates. Vinyl chloride (chloroethylene) is used in the production of plastic polyvinyl chloride. In the pesticide industry it is likely that approximately 26 products may contain a member of this group of priority pollutants (see Table V-18). The principal pollutants likely to be present are 1,2-dichloroethane, which is used as a solvent in ten pesticides; tetrachloroethylene, which is used as a solvent in Pesticides U1 and F1; and trichloroethylene, which is used as a solvent in Pesticide O1.

Chloroethanes and ethylenes have been detected in 10 pesticides, in which the concentrations range from not detected to 10,000 mg/l for 1,2-dichloroethane (see Table V-19).

Nitrosamines

N-nitrosamines are a group of compounds characterized by a nitroso group (N=O) attached to the nitrogen of an aromatic or aliphatic secondary amine. In the pesticide industry N-nitrosodimethylamine and N-nitrosodi-N-propylamine are likely to be present as reaction byproducts from the nitrosation of dimethylamine and di-N-propylamine, respectively. The phenyl nitrosoamine is likely to be present in those processes containing an aniline or N-substituted aniline compound. Table V-20

shows that some form of N-nitrosamine is indicated to be present in a total of 11 pesticides.

The only reported incidence of N-nitrosamines was for Pesticide K1 as shown in Table V-21. Plant monitoring from July 1977 through July 1978 showed an average of 0.123 mg/l N-nitrosodi-N-propylamine. Verification monitoring for three days showed an average level of 1.85 mg/l. The di-methyl and di-ethylamines have been determined by the plant to be in the parts-per-trillion range.

Phthalates

Phthalate esters are used widely as plasticizers in commercial polymers and plastic end products such as polyvinylchloride plastics. Five phthalates classified as priority pollutants are likely to be present in 11 pesticide processes (see Table V-22). Dimethyl phthalate is known to be a raw material in Pesticides K1, E1, and C1. Diethyl, di-n-butyl, and butylbenzyl phthalates are likely to be present as impurities in Pesticide I1 because of the use of phthalic anhydride as a raw material.

As shown in Table V-23, only diethyl phthalate has been monitored and was not detected in a pesticide wastewater stream.

Dichloropropane and Dichloropropene

Table V-24 shows that 1,2-dichloropropane is used as a solvent in Pesticides G1 and M1. 1,3-Dichloropropene is a raw material in Pesticides D1, L1, and B1. 1,3-Dichloropropene is a pesticide product as well as a priority pollutant and functions as an insecticidal fumigant. Halopropanes are likely to be present in 13 pesticide wastewaters; however, monitoring has shown only nondetectable levels in three process wastewaters as shown in Table V-25.

Priority Pollutant Pesticides

There are 18 priority pollutants which are commonly classified as pesticides. Of these, the only five still in production are endrin, heptachlor, chlordane, DDT, and toxaphene. As shown in Table V-26, aldrin, dieldrin, and endrin aldehyde are likely to be present as reaction byproducts in the H1 pesticide process; however, it should be noted that endrin aldehyde occurs as endrin ketone due to thermal rearrangement. Heptachlor epoxide will occur as a reaction byproduct in both B1 and I1 pesticide manufacturing. DDD, DDE, and DDT can occur in the manufacture of Pesticides K1 and F1. While pesticides BHC (alpha, beta, and delta isomers) and lindane (BHC, gamma) are not currently manufactured, the priority pollutant BHC (all isomers) is a potential reaction byproduct in the production of Pesticide M1. Endosulfan sulfate can occur as a reaction byproduct in the manufacture of Pesticide G1. The priority pollutant pesticides BHC, lindane, DDE, DDD, and endosulfan are not currently manufactured, and no raw waste load priority pollutant data are available from past production periods.

As shown in Table V-27 wastewater data are available for all the priority pollutant pesticides currently manufactured, except for Pesticide B1. The only existing waste stream from a Pesticide B1 process is a vent scrubber effluent which is disposed of by deep well injection and is not monitored. The highest level noted was 174 mg/l DDE in Pesticide E1, which is not discharged to a navigable waterway but rather is contract hauled to a Class I landfill. Toxaphene was detected at a declared proprietary level prior to treatment, while endrin, heptachlor, and their byproducts were detected at a declared proprietary level during the verification monitoring program. Previous monitoring of the F1 pesticide process wastewater showed levels of DDT as high as 7.34 mg/l.

Dienes

There are four manufactured pesticides, C1, G1, F1, and D1, and two pesticides currently not manufactured, E1 and H1, which use a priority pollutant diene as a raw material. The basic material for all six pesticides is hexachlorocyclopentadiene (HCCPD). Pesticides C1 and G1 are synthesized by a Diels-Alder condensation of HCCPD and cyclopentadiene to form chlordene, the intermediate. Chlordene is further chlorinated either by addition to produce Pesticide C1 or by substitution to produce Pesticide G1. The F1 pesticide process involves the stepwise reaction of HCCPD with acetylene, cyclopentadiene, and peroxyactetic acid. Pesticide D1 is manufactured by the reductive coupling of HCCPD with itself using a cuprous chloride catalyst. As shown in Table V-28, the priority pollutant hexachlorobutadiene is indicated to be present as a raw material impurity, reaction byproduct, or as a solvent in the manufacture of Pesticide H1. The pesticide products A1 and B1 show potential chlorinated diene contamination as reaction byproducts due to the use of butadiene as a raw material in the presence of perchloromethyl mercaptan.

As shown in Table V-29 monitoring has confirmed that HCCPD exists from less than 1 mg/l to 2,500 mg/l in raw wastewater from four of the indicated pesticides. The level of 2,500 mg/l for HCCPD exceeds the published solubility in water apparently due to sampling from an organic nonaqueous waste stream. Also, where monitoring was conducted, the presence of hexachlorobutadiene was confirmed at approximately 25 percent the strength of HCCPD. It is noted that manufacturers of Pesticides C1 and D1 are disposing of these extremely concentrated wastes by deep well injection and contract hauling, respectively, while G1 and F1 pesticide wastewaters are being discharged to navigable waters after treatment.

TCDD

2,3,7,8-Tetrachlorodibenzo-p-dioxin (TCDD) is believed to be a byproduct in chemical processing generated by a halophenol or chlorobenzene starting material. An intermediate reaction would occur at an elevated temperature, equal to or greater than 150°C, and alkaline conditions or in the presence of a free halogen. The end reaction results in either

direct dioxin, intermediate dioxin, or predioxin formation which would ultimately form dibenzo-p-dioxins (Dryden, et al., 1979). TCDD is indicated to be present in 11 pesticide wastewaters listed in Table V-30. These pesticides use such raw materials as phenol, 2,4-dichlorophenol, 2,4,5-trichlorophenol, and 1,2,4,5-tetrachlorobenzene which are characteristic of TCDD precursors. The structurally similar pesticides H1 and F1 are being examined for possible presence of TCDD in wastewater. As shown in Table V-31, Plant 1 has measured levels of TCDD at less than 0.000002 parts per million to 0.022 parts per million after neutralization of wastewater from their Pesticide B1, J1, and K1 operations. No other available monitoring of wastewater streams has detected TCDD at this time; however, lack of detection does not preclude the existence of TCDD at the parts-per-trillion range or below. Analytical procedures are currently being upgraded. A detection limit of 0.003 ug/1 is currently achievable (U.S. EPA, 1979b).

A study by Oswald in 1978 detailed results of analysis of fish samples from three rivers in Michigan for 2,3,7,8-TCDD. Thirty-five samples were analyzed by high resolution capillary column gas chromotography interfaced with high resolution mass spectometry. Concentrations in 35 samples ranged from 4 ng/1 to 695 ng/1.

A TCDD level as high as 111 mg/1 has been found in drums of waste from the production of the pesticide 2,4,5-T, according to Final Rules published May 19, 1980 in the Federal Register (U.S. EPA, 1980a). The EPA TCDD task force is currently reviewing the environmental problems of TCDD residue.

Miscellaneous

Acrolein is manufactured for use in plastics and as a warning agent in methyl chloride refrigerant. It is not likely to be present, nor has it been found, as a process-related pollutant in the pesticide industry.

Acrylonitrile is used in the manufacture of synthetic fibers, dyes, and adhesives. It is likely to be present in the A1 pesticide process where it is likely to be used as a raw material or solvent. Acrylonitrile has not been monitored in the pesticide industry.

Asbestos is in widespread usage as an insulating material. As shown in Table V-32, total mass chrysotile fibers of asbestos were found in pesticide process wastewaters at concentrations from not detected or 0.000038 mg/1 to 0.3 mg/1. These data were reported as part of an EPA asbestos screening sampling program and represents monitoring of combined pesticide and nonpesticide process wastewaters.

1,2-Diphenylhydrazine is a chemical intermediate which is not used, and has not been found in the pesticide industry.

Isophorone is a diene compound (2-cyclohexene-1-one-3,5,5 trimethyl) classified as a priority pollutant. Unlike the other priority

pollutant dienes, it is not chlorinated and is not likely to be present, nor has it been found in any of the processes investigated.

PCBs

For the past 50 years PCBs have had widespread industrial applications as hydraulic fluids, plasticizers in synthetic resins and rubbers, adhesives, heat transfer systems, wax extenders, dedusting agents, pesticide extenders, inks, lubricants, and cutting oils. Most of these uses have been banned, but PCBs are still used in vacuum pumps, gas transmission turbines, and electrical capacitors and transformers.

The only pesticide process where PCBs are likely to occur in the actual manufacturing scheme is A1, where they could be present as reaction byproducts. However, the manufacture of Pesticide A1 has recently been ceased and is not anticipated to be produced in the future. Therefore PCBs are no longer indicated to be present in this industry.

Benzidines

Benzidine compounds are synthetically-produced compounds used primarily in the manufacture of dyes. They are not likely to be present nor have they been found to be present as process-related pollutants in the pesticide industry.

NONCONVENTIONAL POLLUTANTS

The raw waste load concentrations and flows for nonconventional pollutants are presented in Table V-33 for each of the 280 pesticides for which data are available.

Nonconventional Pesticides

Nonconventional pesticides have been monitored in 44 percent of pesticide raw waste streams. Table V-33 presents raw waste load concentrations ranging from not detected to 11,200 mg/l. From these data an evaluation can be made of the number of pesticide processes that could potentially require some type of pesticide removal technology. For example, if a pretreatment objective of 1 mg/l were established, then the following conclusions could be drawn: one-fourth of the pesticides require no treatment, one-half require less than 90 percent removal, two-thirds require less than 99 percent removal, five-sixths require less than 99.9 percent removal, and one-sixth require more than 99.9 percent removal.

COD

COD has been monitored in 27 percent of pesticide raw waste streams. Table V-33 presents COD concentrations ranging from 14.0 mg/l to 1,220,000 mg/l.

TOC

TOC has been monitored in 11 percent of pesticide raw waste streams. Table V-33 presents TOC concentrations ranging from 53.2 mg/l to 79,800 mg/l.

TOD

Raw waste load concentrations of TOD have not been monitored in the pesticide industry.

CONVENTIONAL POLLUTANTS

The raw waste load concentrations and flows for conventional pollutants are presented in Table V-34 for each of the 280 pesticides for which data are available.

BOD

BOD has been monitored in 27 percent of pesticide raw waste streams. Table V-34 presents detected BOD concentrations ranging from not detected to 60,000 mg/l. The oxygen demand is quite high as pesticide wastewaters leave the process. This demand must be further evaluated at sampling points immediately prior to biological oxidation systems, since pretreatment steps (such as activated carbon) can effect considerable organic removal.

TSS

TSS has been monitored in 24 percent of pesticide raw waste streams. Table V-34 presents detected TSS concentrations ranging from 2.00 mg/l to 4,090 mg/l.

DESIGN RAW WASTE LOADS

A raw waste load must be selected in order to design and cost recommended treatment and control technologies. The approach taken in this study is to design for the removal of maximum priority pollutant raw waste concentrations. This ensured that the economic impact to treat high level pollutants would be adequately considered in a plant-by-plant analysis. A summary of raw waste load design levels taken from Tables V-2 through V-34 are provided in Table V-35.

ZERO-DISCHARGE PRODUCTS

Table V-36 presents a listing of 29 pesticide products which are currently being manufactured with zero discharge of process wastewater to municipal treatment systems or to navigable waterways. This determination was made from examination of process flow diagrams, and from manufacturers' responses to the 308 Survey and follow-up letters.

Table V-1. Likely to be Present/Detected Frequency of Priority Pollutant Groups

Priority Pollutant Group	Number of Pesticides in Group	
	Likely to be Present	Detected
Volatile Aromatics	121	44
Halomethanes	56	25
Cyanides	25	13
Haloethers	30	4
Phenols	34	20
Nitro-Substituted Aromatics	27	2
Polynuclear Aromatics	25	5
Metals	22	8
Chlorinated Ethanes(ylenes)	26	10
Nitrosamines	11	1
Phthalates	11	1
Dichloropropane(ene)	13	3
Pesticides	13	5
TCDD	11	4
Dienes	8	4
Miscellaneous	1	76*
PCBs	0	0
Benzidines	0	0

* Refers to priority pollutant asbestos only.

Table V-2. Volatile Aromatics Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3 di-chlorobz	1,4 di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
A1	IS	S	IS	—	—	—	—	—	—
B1	IS	S	IS	S	IS	IS	IS	—	IS
C1	S,IS	S,IS	IS	—	—	—	—	—	—
D1	IS	S	IS	—	—	—	—	—	—
E1	—	—	—	I	—	—	—	—	—
F1	IS	S	IS	—	—	—	—	—	—
G1	IS	S	IS	—	—	—	U	U	—
H1	IS	S	IS	—	—	—	—	—	—
I1	IS	S	IS	—	—	—	—	—	—
J1	—	—	—	R	I	I	I	—	—
K1	IS	S	IS	—	—	—	—	—	—
L1	IS	S	IS	—	—	—	—	—	—
M1	R	I	I	—	—	—	—	—	—
N1	R	R	I	—	—	—	—	—	—
O1	IS	IS	IS	—	—	—	—	—	—
P1	IS	IS	IS	—	—	—	—	—	—
Q1	IS	S	IS	—	—	—	—	—	—
R1	IS	S	IS	—	—	—	—	—	—
S1	IS	S	IS	—	—	—	—	—	—
T1	S	IS	IS	—	—	—	—	—	—
U1	IS	IS	IS	I	—	—	—	—	—
V1	R	I	I	P	B	B	B	B	B
W1	IS	S	IS	—	—	—	—	—	—
X1	S	IS	IS	R	I	I	I	I	I
Y1	IS	S	IS	—	—	—	—	—	—
Z1	IS	S	IS	—	—	—	—	—	—
A2	IS	S	IS	—	—	—	—	—	—
B2	IS	S	IS	I	I	I	I	I	I
C2	IS	IS	IS	B	B	B	B	B	B
D2	I	—	—	R	I	I	I	—	I
E2	I	—	—	R	I	I	I	—	I
F2	I	I	I	R	I	I	I	I	I
G2	IS	S	IS	—	—	—	—	—	—
H2	IS	S	IS	—	—	—	—	—	—
I2	IS	S	IS	—	—	—	—	—	—
J2	IS	S	IS	—	—	—	—	—	—

Footnotes at end of table

Table V-2. Volatile Aromatics Likely to be Present in Pesticide Process Wastewaters (Continued, Page 2 of 4)

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3 di-chlorobz	1,4 di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
K2	IS	S	IS	—	—	—	—	—	—
L2	IS	IS	IS	I	I	I	I	I	I
M2	R	I	I	B	P	B	B	B	B
N2	R	I	I	B	B	B	P	B	B
O2	IS	S	IS	—	—	—	—	—	—
P2	S	IS	IS	B	B	B	B	B	B
Q2	I	—	—	I	I	I	I	I	I
R2	IS	S	IS	—	—	—	—	—	—
S2	IS	IS	IS	S	IS	IS	IS	IS	IS
T2	—	—	—	—	—	—	—	U	—
U2	I,IS	S	IS	U	—	—	—	—	—
V2	IS	S	IS	—	—	—	—	—	—
W2	—	I	—	—	—	—	—	—	—
X2	—	I	—	—	—	—	—	—	—
Y2	IS*	—	—	—	—	—	—	—	—
Z2	IS	IS	IS	—	—	—	—	—	—
A3	IS	S	IS	—	—	—	—	—	—
B3	IS	S	IS	—	—	—	—	—	—
C3	IS	S	IS	—	—	—	—	—	—
D3	S	IS	IS	I	—	—	—	—	—
E3	IS	S	IS	—	—	—	—	—	—
F3	IS	S	IS	—	—	—	—	—	—
G3	IS	S	IS	—	—	—	—	—	—
H3	—	—	—	—	—	—	—	U	—
I3	IS	S	IS	—	—	—	—	—	—
J3	IS	S	IS	—	—	—	—	—	—
K3	—	I	—	—	—	—	—	—	—
L3	IS	IS	IS	I	I	I	I	—	I
M3	IS	S	IS	—	—	—	—	—	—
N3	IS	IS	IS	—	—	—	—	—	—
O3	R	I	I	—	—	—	—	—	—
P3	IS	—	—	S	IS	IS	IS	IS	IS
Q3	IS	S	IS	—	—	—	—	—	—
R3	IS	S	IS	—	—	—	—	—	—
S3	IS	S	IS	—	—	—	—	—	—

Footnotes at end of table

Table V-2. Volatile Aromatics Likely to be Present in Pesticide Process Wastewaters (Continued, Page 3 of 4)

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3 di-chlorobz	1,4 di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
T3	IS	S	IS	—	—	—	—	—	—
U3	IS	S	IS	—	—	—	—	—	—
V3	S	IS	IS	—	—	—	—	—	—
W3	S, IS	S, IS	IS	—	—	—	—	—	—
X3	IS	S	IS	—	—	—	—	—	—
Y3	IS	S	IS	—	—	—	—	—	—
Z3	IS	S	IS	—	—	—	—	—	—
A4	IS	IS	IS	I	I	I	I	—	I
B4	IS	S	IS	—	—	—	—	—	—
C4	IS	S	IS	—	—	—	—	—	—
D4	IS	IS	IS	I	—	—	—	—	—
E4	IS	IS	IS	I	—	—	—	—	—
F4	I	I	I	I	I	I	I	B	I
G4	—	—	—	I	I	I	I	B	I
H4	I	I	R	B	—	—	—	—	—
I4	I	—	—	R	I	I	I	—	I
J4	I	—	—	R	I	I	I	—	I
K4	IS	S	IS	—	—	—	—	—	—
L4	S	IS	IS	—	—	—	—	—	—
M4	S	IS	IS	—	—	—	—	—	—
N4	IS	S	IS	S	IS	IS	IS	—	IS
O4	IS	S	IS	—	—	—	—	—	—
P4	IS	S	IS	—	—	—	—	—	—
Q4	IS	S	IS	—	—	—	—	—	—
R4	IS	S	IS	—	—	—	—	—	—
S4	IS	S	IS	—	—	—	—	—	—
T4	IS	IS	IS	—	—	—	—	—	—
U4	IS	S	IS	—	—	—	—	—	—
V4	IS	IS	IS	—	—	—	—	—	—
W4	IS	S	IS	—	—	—	—	—	—
X4	IS	S	IS	—	—	—	—	—	—
Y4	—	—	—	U	—	—	—	—	—
Z4	IS	S	IS	—	—	—	—	—	—

Footnotes at end of table

Table V-2. Volatile Aromatics Likely to be Present in Pesticide Process Wastewaters (Continued, Page 4 of 4)

Pesticide Produced	AROMATICS, CHLORINATED AROMATICS								
	Benzene	Toluene	Ethylbz	Chlorobz	1,2 di-chlorobz	1,3 di-chlorobz	1,4 di-chlorobz	Hexa-chlorobz	1,2,4 TCBz
A5	IS	S	IS	—	—	—	—	—	—
B5	IS	S	IS	—	—	—	—	—	—
C5	S	IS	IS	—	—	—	—	—	—
D5	—	—	—	I	I	I	I	I	I
E5	S	IS	IS	—	—	—	—	—	—
F5	IS	S	IS	—	—	—	—	—	—
G5	IS	S	IS	—	—	—	—	—	—
H5	IS	S	IS	—	—	—	—	—	—
I5	IS	S	IS	—	—	—	—	—	—
J5	I	—	—	—	—	U	—	—	—
K5	IS	S	IS	—	—	—	—	—	—
L5	IS	IS	IS	IS	IS	IS	IS	—	IS
M5	IS	S	IS	—	—	—	—	—	—
N5	IS	S	IS	—	—	—	—	—	—
O5	IS	S	IS	—	—	—	—	—	—
P5	R	I	I	B	B	B	B	B	B
Q5	IS	IS	IS	—	—	—	—	—	—

* = Ethanol denatured with benzene.
† = Alpha, beta, and delta isomers.
R = Raw material.
I = Raw material impurity.
S = Solvent.
IS = Solvent impurity.
ST = Organic stripper solvent.
IST = Stripper impurity.
B = Reaction byproduct.
U = Unknown—pollutant reported by plant, source not determined.
— = Not likely to be present.
P = Final product.

Ethybz = Ethylbenzene.
Chlorobz = Chlorobenzene.
TCBz = Trichlorobenzene.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters

AROMATICS, CHLORINATED AROMATICS

BENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
O4	1/01	ND†	(1)	0.0315
G2	1/02	ND†	(1)	0.0315
S4	2/02	0.073	(3)	0.012
M2	3/02	0.0877†	(16)	0.0391
N2	4/02	0.0877†	(16)	0.0391
I3	5/02	<0.10†	(2)	2.3
V1	6/02	0.220†	(3)	28.2
M2	7/02	0.220†	(3)	28.2
N2	8/02	0.220†	(3)	28.2
I4	9/02	0.220†	(3)	28.2
J4	10/02	0.220†	(3)	28.2
H2	11/02	0.580*	(1)	1.8
W1	12/02	2.68†	(3)	1.241
T1	13/02	3.00	(22)	0.00156
V1	14/02	52*	(111)	0.094
M2	15/02	52*	(111)	0.094
N2	16/02	52*	(111)	0.094
P5	17/02	52*	(111)	0.094
F3	18/02	180,000	(1)	0.000276
J5	1/04	30	(1)	1.5
C3	1/05	0.580*	(1)	1.8
D4	1/08	0.07	(1)	0.7224
E4	2/08	0.07	(1)	0.7224
F4	1/09	0.0051	(2)	0.009
B2	2/09	<0.010*	(3)	0.1027
L2	3/09	<0.01*	(1)	1.22
P3	4/09	<0.10†	(2)	2.3
B2	5/09	0.220†	(3)	28.2
B2	6/09	<0.30°	(3)	0.084

ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Analysis not conducted per protocol.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 2 of 11)

AROMATICS, CHLORINATED AROMATICS

BENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
R2	7/09	0.580*	(1)	1.8
L2	8/09	0.767	(3)	0.0717
K2	9/09	2.68†	(3)	1.241
Q4	1/10	2.68†	(3)	1.241

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 3 of 11)

AROMATICS, CHLORINATED AROMATICS

TOLUENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
O4	1/01	0.137†	(1)	0.030
R1	2/01	<69.3	(5)	0.0665
T4	1/02	Trace	(1)	NA
S4	2/02	0.030	(3)	0.012
G2	3/02	0.137†	(1)	0.030
H2	4/02	0.180*	(1)	1.8
H2	5/02	0.21*	(1)	1.8
I3	6/02	1.40†	(3)	2.3
U2	7/02	1.49	(10)	0.130
V1	8/02	5.40†	(3)	28.2
M2	9/02	5.40†	(3)	28.2
N2	10/02	5.40†	(3)	28.2
I3	11/02	7.42†	(2)	2.3
V2	12/02	11.7	(E)	0.161
W1	13/02	15.3†	(3)	1.241
L1	14/02	350	(1)	0.000054
F3	15/02	294,000	(1)	0.000276
C3	1/05	0.180*	(1)	1.8
O2	2/05	20,000	(1)	0.00118
D4	1/08	0.10*	(1)	0.7224
E4	2/08	0.10*	(1)	0.7224
L2	1/09	ND	(3)	0.3283
F4	2/09	<0.0050	(2)	0.009
L2	3/09	<0.01*	(1)	1.22
B2	4/09	0.016*	(3)	0.1027
R2	5/09	0.180*	(1)	1.8
R2	6/09	0.21*	(1)	1.8
B2	7/09	5.40†	(3)	28.2
K2	8/09	15.3†	(3)	1.241

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 4 of 11)

AROMATICS, CHLORINATED AROMATICS

TOLUENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
B2	9/09	28.5*	(1)	0.20
Z4	10/09	28.5*	(1)	0.20
F5	11/09	28.5*	(1)	0.20
S1	12/09	370*	(20)	0.021
B2	13/09	528	(3)	0.101
B2	14/09	686	(30)	0.101
B2	15/09	1,570	(28)	0.101
G1	1/10	2.69*	(540)	2.5
U4	2/10	2.69*	(540)	2.5
A5	3/10	2.69*	(540)	2.5
G1	4/10	5.80*	(270)	1.3
U4	5/10	5.80*	(270)	1.3
A5	6/10	5.80*	(270)	1.3
Q4	7/10	15.3†	(3)	1.241

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 5 of 11)

AROMATICS, CHLORINATED AROMATICS

ETHYLBENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
O4	1/01	0.338†	(1)	0.030
S4	1/02	<0.005	(3)	0.012
I3	2/02	0.203†	(2)	2.3
G2	3/02	0.338†	(1)	0.030
I3	4/02	1.00†	(1)	2.3
V1	5/02	7.90†	(3)	28.2
M2	6/02	7.90†	(3)	28.2
N2	7/02	7.90†	(3)	28.2
C3	1/05	ND*	(1)	1.8
E4	1/08	<0.01	(1)	6,050 gal/ 1,000 lbs
R2	1/09	ND*	(1)	1.8
F4	2/09	ND	(2)	0.009
L5	3/09	<0.01*	(1)	1.22
B2	4/09	7.90†	(3)	28.2

ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 6 of 11)

AROMATICS, CHLORINATED AROMATICS

CHLOROBENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
D5	1/02	ND*	(1)	NA
I4	2/02	<0.005*	(1)	0.00002
J4	3/02	<0.005*	(1)	0.00002
M2	4/02	0.195†	(16)	0.0391
N2	5/02	0.195†	(16)	0.0391
V1	6/02	3.0†	(3)	28.2
I4	7/02	3.0†	(3)	28.2
M2	8/02	3.0†	(3)	28.2
N2	9/02	3.0†	(3)	28.2
J4	10/02	3.0†	(3)	28.2
V1	11/02	135*	(111)	0.094
M2	12/02	135*	(111)	0.094
N2	13/02	135*	(111)	0.094
P5	14/02	135*	(111)	0.094
D4	1/08	0.30*	(1)	NA
E4	2/08	0.30*	(1)	NA
F4	1/09	<0.01	(3)	0.0033
L2	2/09	<0.01	(3)	1.22
B2	3/09	3.0†	(3)	28.2
P3	4/09	3.77†°	(2)	2.3
L2	5/09	6.31	(3)	0.0717
P3	6/09	5.00†	(3)	2.3
F2	7/09	979	(1)	0.0163
E1	1/10	ND	(1)	NA

ND = Not detected.
NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Analysis not conducted per protocol.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 7 of 11)

AROMATICS, CHLORINATED AROMATICS

1,2-DICHLOROBENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
V1	1/02	0.023†	(3)	28.2
M2	2/02	0.023†	(3)	28.2
M2	3/02	0.023†	(3)	28.2
N2	4/02	0.023†	(3)	28.2
I4	5/02	0.023†	(3)	28.2
J4	6/02	0.023†	(3)	28.2
V1	7/02	127*	(111)	0.094
M2	8/02	127*	(111)	0.094
N2	9/02	127*	(111)	0.094
P5	10/02	127*	(111)	0.094
B2	1/09	ND	(1)	NA
L2	2/09	ND†	(1)	2.3
B2	3/09	0.023*	(3)	28.2
F4	4/09	<0.113	(3)	0.0033

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 8 of 11)

AROMATICS, CHLORINATED AROMATICS

1,3-DICHLOROBENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
V1	1/02	0.410†	(3)	28.2
M2	2/02	0.410†	(3)	28.2
N2	3/02	0.410†	(3)	28.2
I4	4/02	0.410†	(3)	28.2
J4	5/02	0.410†	(3)	28.2
V1	6/02	127*	(111)	0.094
M2	7/02	127*	(111)	0.094
N2	8/02	127*	(111)	0.094
P5	9/02	127*	(111)	0.094
B2	1/09	ND	(1)	NA
F4	2/09	ND	(1)	NA
L2	3/09	<0.120	(3)	2.3
B2	4/09	0.410*	(3)	28.2

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 9 of 11)

AROMATICS, CHLORINATED AROMATICS

1,4-DICHLOROBENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
G1	1/01	ND	(1)	NA
V1	1/02	0.470†	(3)	28.2
M2	2/02	0.470†	(3)	28.2
N2	3/02	0.470†	(3)	28.2
I4	4/02	0.470†	(3)	28.2
J4	5/02	0.470†	(3)	28.2
V1	6/02	85*	(111)	0.094
M2	7/02	85*	(111)	0.094
N2	8/02	85*	(111)	0.094
P5	9/02	85*	(111)	0.094
B2	1/09	ND	(1)	NA
P3	2/09	ND†	(1)	2.3
F4	3/09	ND	(1)	NA
B2	4/09	0.470*	(3)	28.2

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 10 of 11)

AROMATICS, CHLORINATED AROMATICS

HEXACHLOROBENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
G1	1/01	ND	(1)	NA
B2	1/09	ND	(1)	NA
T2	2/09	ND*	(1)	NA
H3	3/09	ND*	(1)	NA
P3	4/09	ND†	(1)	2.3
F4	5/09	<0.008	(2)	0.0033

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-3. Volatile Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 11 of 11)

AROMATICS, CHLORINATED AROMATICS

1,2,4-TRICHLOROBENZENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
D5	1/02	ND	(1)	NA
V1	2/02	36*	(47)	0.094
M2	3/02	36*	(47)	0.094
N2	4/02	36*	(47)	0.094
P5	5/02	36*	(47)	0.094
P3	1/09	ND†	(1)	2.3
F4	2/09	0.0296	(2)	0.0033

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-4. Halomethanes Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	HALOMETHANES							
	Methyl chloride	Methyl bromide	Methylene chloride	Chloro-form	Bromo-form	Dichloro-bromo-methane	Chloro-dibromo-methane	Carbon tetra-chloride
A1	IST	--	ST	IST	--	--	--	IST
B1	B	--	B	B	--	--	--	B
C1	IST	--	ST	IST	--	--	--	IST
D1	IS	--	IS	IS	--	--	--	S
E1	IS	--	IS	S	--	--	--	IS
F1	R	--	I	I	--	--	--	--
G1	B	--	IS	IS	--	--	--	S
H1	--	--	B	B	B	B	B	B
I1	IS	--	S	IS	--	B	--	IS
J1	B	--	B	B	--	--	--	B
K1	IS	--	S	IS	--	--	--	IS
L1	B	--	B	B	--	--	--	B
M1	IS	--	IS,B	IS,B	--	--	--	S
N1	--	B	--	--	B	--	B	--
O1	IS	--	S	IS	--	--	--	S
P1	IS	--	S	IS	--	--	--	IS
Q1	B	--	B	B	--	--	--	B
R1	IST	--	ST	IST	--	--	--	IST
S1	IST	--	ST	IST	--	--	--	IST
T1	IS	--	IS,B	IS,B	--	--	--	B
U1	B	--	B	B	--	--	--	B
V1	R	--	I	I	--	--	--	--
W1	B	--	--	--	--	--	--	--
X1	IS	--	S	IS	--	--	--	IS
Y1	I	--	I	I	--	--	--	I
Z1	B	--	B	B	--	--	--	B
A2	--	I	--	--	I	--	--	--
B2	--	B	--	--	B	--	--	--
C2	--	--	IS	IS	--	--	--	S
D2	IS	--	IS	S	--	--	--	IS
E2	IS	--	S	IS	--	--	--	IS
F2	IS	--	IS	IS	--	--	--	S
G2	IS	--	S	IS	--	--	--	IS
H2	IS	--	S	IS	--	--	--	IS
I2	I	--	I	I	--	--	--	I
J2	--	P	--	--	B	--	--	--

Footnotes at end of table

Table V-4. Halomethanes Likely to be Present in Pesticide Process Wastewaters (Continued, Page 2 of 2)

Pesticide Produced	HALOMETHANES							
	Methyl chloride	Methyl bromide	Methylene chloride	Chloro-form	Bromo-form	Dichloro-bromo-methane	Chloro-dibromo-methane	Carbon tetra-chloride
K2	I	—	I	I	—	—	—	I
L2	—	R	—	—	I	—	—	—
M2	B	—	S	IS	—	—	—	IS
N2	B	—	B	B	—	—	—	B
O2	B	—	IS	S	—	—	—	IS
P2	IS	—	IS	IS	—	—	—	S
Q2	IS	—	IS	IS	—	—	—	S
R2	R	—	I	I	—	—	—	—
S2	B	—	B	B	—	—	—	—
T2	B	—	B	B	—	—	—	B
U2	IS	—	IS	IS	—	—	—	S
V2	IS	—	S	IS	—	—	—	IS
W2	IS	—	IS	IS	—	—	—	S
X2	IS	—	IS	S	—	—	—	IS
Y2	IS	—	IS	IS	—	—	—	S
Z2	B	—	S	IS	—	—	—	IS
A3	IS	—	S	IS	—	—	—	IS
B3	IS	—	IS	IS	—	—	—	S
C3	IS	—	IS	IS	—	—	—	S
D3	B	—	B	B	—	—	—	B

R = Raw material.
I = Raw material impurity.
S = Solvent.
IS = Solvent impurity.
ST = Organic stripper solvent.
IST = Stripper impurity.
B = Reaction byproduct.
-- = Not likely to be present.
P = Final product.

Methyl chloride = (Chloromethane).
Methyl bromide = (Bromomethane).
Methylene chloride = (Dichloromethane).
Chloroform = (Trichloromethane).
Bromoform = (Tribromomethane).
Carbon tetrachloride = (Tetrachloride).

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters

HALOMETHANES				
METHYL CHLORIDE				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
D1	1/01	ND	(1)	NA
W1	2/01	ND*°	(1)	NA
M2	3/01	<1.0*	(1)	0.008
V2	1/02	ND	(1)	NA
Z2	2/02	ND*°	(1)	NA
S2	1/08	ND	(1)	0.7224
V1	1/09	ND	(3)	0.3283
F2	2/09	ND*	(1)	NA
B3	3/09	ND	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
° = Analysis not conducted per protocol.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 2 of 7)

HALOMETHANES				
METHYL BROMIDE				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
J2	1/02	1.10†	(3)	28.2
J2	2/02	53.8	(2)	0.0086
J2	3/02	2,600	(1)	0.0086

† = Data from comingled pesticide/other product stream.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters
(Continued, Page 3 of 7)

HALOMETHANES

METHYLENE CHLORIDE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
C1	1/01	None	(E)	0.0451
K1	2/01	12.7°	(3)	0.00323
U1	1/02	0.010*	(1)	1.8
H2	2/02	<0.010†	(3)	0.154
B1	3/02	0.017*	(2)	1.034
H2	4/02	0.0233†	(3)	0.154
Z2	5/02	0.453*	(3)	0.110
U1	6/02	0.55*	(1)	1.8
H1	7/02	4.17†	(3)	2.3
S1	8/02	<75.2	(2)	0.022
H1	9/02	76.0†	(2)	2.3
O1	10/02	31,000	(50)	0.0014
B3	1/09	<0.01*	(1)	NA

NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product stream.
° = Analysis not conducted per protocol.
(E) = Estimate.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 4 of 7)

HALOMETHANES				
CHLOROFORM				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
K1	1/01	<0.30°	(3)	0.00323
V2	1/02	0.0149	(3)	1.24
S1	2/02	<0.029	(2)	0.022
H2	3/02	0.0367†	(3)	0.154
H1	4/02	0.111†	(2)	2.3
H2	5/02	0.170†	(3)	0.154
U1	6/02	0.200*	(1)	1.8
Z2	7/02	<1.55*	(3)	0.110
H2	8/02	70.0*	(10)	0.043
O2	1/05	70.0*	(10)	0.043
O2	2/05	3,000	(2)	0.021
S2	1/08	0.017*	(1)	NA
F2	1/09	0.382*	(3)	0.1893
B3	2/09	0.623*	(3)	1.22
B3	3/09	6.31	(3)	0.0717

NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product stream.
° = Analysis not conducted per protocol.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters
(Continued, Page 5 of 7)

HALOMETHANES				
BROMOFORM				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
B2	1/01	ND	(1)	0.0533
H1	1/02	ND†	(3)	2.3
H1	2/02	<0.010†	(2)	2.3
L2	1/10	ND	(1)	1.8

ND = Not detected.
† = Data from comingled pesticide/other product stream.
(n) = Number of data points.

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters (Continued, Page 6 of 7)

HALOMETHANES

DICHLOROBROMOMETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

CHLORODIBROMOMETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-5. Halomethanes Detected in Pesticide Process Wastewaters
(Continued, Page 7 of 7)

HALOMETHANES

CARBON TETRACHLORIDE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
H2	1/02	ND	(3)	0.154
S1	2/02	<0.001	(3)	0.022
H1	3/02	<0.010†	(2)	2.3
H2	4/02	<0.010†	(3)	0.154
H1	5/02	0.025†	(3)	2.3
B3	1/09	10.5*	(3)	1.22
Y1	2/09	67.9*	(3)	0.1893
F2	3/09	67.9*	(3)	0.1893
B3	4/09	121	(3)	0.0717
D1	1/10	<0.160*	(270)	1.3
W2	2/10	<0.160*	(270)	1.3
Y2	3/10	<0.160*	(270)	1.3
D1	4/10	0.168*	(540)	2.5
W2	5/10	0.168*	(540)	2.5
Y2	6/10	0.168*	(540)	2.5

ND = Not detected.
* = Data from comingled pesticide stream.
† = Data from comingled pesticide/other product stream.
(n) = Number of data points.

Table V-6. Cyanides Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	Raw Material	Potential Cyanide Contamination
A1	Cyanuric chloride	I, B
B1	Cyanuric chloride	I, B
C1	Cyanuric chloride	I, B
D1	Methyl cyanocarbamate	B
E1	Isophthalodinitrile	B
F1	Cyanuric chloride	I, B
G1	Cyanamide	R
H1	Potassium cyanide	R
I1	Sodium cyanide	R
J1	Sodium thiocyanate	I, B
K1	Cyanamide 50	R
L1	Sodium thiocyanate	I, B
M1	Cyanuric chloride	I, B
N1	Cyanamide	R
O1	2-Cyanopyridine	I, B
P1	Cyanuric chloride	I, B
Q1	Cyanuric chloride	I, B
R1	Cyanuric chloride	I, B
S1	Benzyl cyanide	I, B
T1	Cyanuric chloride	I, B
U1	Cyanuric chloride	I, B
V1	Ammonium thiocyanate	I, B
W1	Cyanuric chloride	I, B
X1	Cyanuric chloride	I, B
Y1	Thiazole	B

R = Raw material.
I = Raw material impurity.
B = Reaction byproduct.

Table V-7. Cyanides Detected in Pesticide Process Wastewaters

CYANIDE				
CYANIDE				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
D1	1/02	ND†	(1)	0.0202
I1	1/04	1.22*	(772)	1.42
C1	1/10	ND*	(270)	1.3
R1	2/10	ND*	(270)	1.3
T1	3/10	ND*	(270)	1.3
C1	4/10	0.105*	(540)	2.5
R1	5/10	0.105*	(540)	2.5
T1	6/10	0.105*	(540)	2.5
P1	7/10	1.22*	(772)	1.42
Q1	8/10	1.22*	(772)	1.42
R1	9/10	1.22*	(772)	1.42
T1	10/10	1.22*	(772)	1.42
U1	11/10	1.22*	(772)	1.42
W1	12/10	1.22*	(772)	1.42
X1	13/10	1.22*	(772)	1.42
Q1	14/10	2.16*	(3)	1.2412
F1	15/10	3.02	(44)	NA
A1	16/10	5.04	(34)	NA
F1	17/10	5,503°	(3)	0.0634

NA = Not available.
ND = Not detected.
† = Data from comingled pesticide/other product streams.
* = Data from comingled pesticide streams.
° = Analysis not conducted per protocol.
(n) = Number of data points.

Table V-8. Halogenated Ethers Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT HALOGENATED ETHERS					
	BCEE	CEVE	BCIPE	BCEM	CPPE	BPPE
A1	B	B	B	--	--	--
B1	--	--	--	--	B	--
C1	--	--	--	--	B	--
D1	R	I,B	I,B	I,B	B	--
E1	--	--	--	--	B	--
F1	B	B	B	B	--	--
G1	--	--	--	--	B	--
H1	--	--	--	--	B	--
I1	I	I	I	--	--	--
J1	I	I	I	--	--	--
K1	--	--	--	--	B	--
L1	--	--	--	--	B	--
M1	P	B	B	B	--	--
N1	--	--	--	--	B	--
O1	--	--	--	--	B	--
P1	--	--	--	--	B	--
Q1	B	B	B	B	--	--
R1	I,B	I,B	I,B	I,B	--	--
S1	B	B	B	B	--	--
T1	--	--	--	--	B	--
U1	--	--	--	--	--	B
V1	R	I,B	I,B	I,B	--	--
W1	--	--	--	--	B	--
X1	--	--	--	--	B	--
Y1	B	B	B	B	B	--
Z1	--	--	--	--	B	--
A2	--	--	--	--	B	--
B2	--	--	--	--	B	--
C2	--	--	--	--	B	--
D2	--	--	--	--	B	--

I = Raw material impurity.
B = Reaction byproduct.
P = Final product.
-- = Not likely to be present.

BCEE = bis(2-chloroethyl) ether.
CEVE = 2-chloroethyl vinyl ether.
BCIPE = bis(2-chloroisopropyl) ether.
BCEM = bis(2-chloroethoxy) methane.
CPPE = 4-chlorophenyl phenyl ether.
BPPE = 4-bromophenyl phenyl ether.

Table V-9. Haloethers Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT HALOGENATED ETHER

BIS(2-CHLOROETHYL) ETHER

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
Y1	1/01	ND†	(1)	0.030
S1	1/02	ND	(1)	NA
R1	1/04	0.582†	(3)	1.49

NA = Not available.
ND = Not detected.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

2-CHLOROETHYL VINYL ETHER

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
Y1	1/01	ND	(1)	0.03
S1	1/02	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

Table V-9. Haloethers Detected in Pesticide Process Wastewaters
(Continued, Page 2 of 3)

PRIORITY POLLUTANT HALOGENATED ETHER

BIS(2-CHLOROISOPROPYL) ETHER

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
Y1	1/01	ND	(1)	0.03
S1	1/02	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

BIS(2-CHLOROETHOXY) METHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
Y1	1/01	ND	(1)	0.03
S1	1/02	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

Table V-9. Haloethers Detected in Pesticide Process Wastewaters (Continued, Page 3 of 3)

PRIORITY POLLUTANT HALOGENATED ETHER

4-CHLOROPHENYL PHENYL ETHER

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
E1	1/01	ND	(1)	NA
Y1	2/01	ND	(1)	0.03

NA = Not available.
ND = Not detected.
(n) = Number of data points.

4-BROMOPHENYL PHENYL ETHER

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-10. Phenols Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PHENOLIC PRIORITY POLLUTANTS									
	P	2-CP	24-DCP	246-TCP	PCP	2-NP	4-NP	24-DNP	4-CMC	24-DMP
A1	I	—	—	—	—	—	—	—	—	—
B1	—	—	R	I	—	—	—	—	—	—
C1	B	B	B	B	—	—	—	—	—	—
D1	B	—	—	—	—	—	—	—	—	—
E1	B	B	B	B	B	—	—	—	—	—
F1	—	B	—	—	—	—	—	—	—	—
G1	I	B	R	B	—	—	—	—	—	—
H1	I	I	R	I	—	—	—	—	—	—
I1	I	I/B	I	I	B	—	—	—	—	—
J1	—	—	R	—	B	—	—	—	—	—
K1	I/B	—	—	—	—	—	—	—	—	—
L1	—	—	R	—	—	—	—	—	—	—
M1	I	—	—	—	—	I	—	I/R	—	—
N1	I	—	—	—	—	—	R	—	—	—
O1	I/B	—	—	—	—	—	—	—	I/B	I/B
P1	—	—	—	I	B	—	—	—	—	—
Q1	I	B	I/B	I/B	—	—	—	—	—	—
R1	I	I	I/B	I/B	—	—	—	—	I	I
S1	I	—	—	—	—	—	—	—	—	—
T1	I	—	—	—	—	—	—	—	—	—
U1	I	—	—	—	—	—	—	—	—	—
V1	I	I/B	R	I	B	—	B	—	—	—
W1	—	—	—	—	—	—	R	—	—	—
X1	—	—	—	—	—	I	R	I	—	—
Y1	R	B	B	B	P	—	—	—	—	—
Z1	B	B	B	B	—	—	—	—	—	—
A2	B	B	B	B	—	—	—	—	—	—
B2	I	—	—	—	—	—	—	—	—	—
C2	—	—	I	—	—	—	—	—	—	—
D2	I	I	B	—	—	—	—	—	—	—
E2	I	B	B	—	—	—	—	—	—	—
F2	—	—	R	—	—	—	—	—	—	—
G2	—	I	I	I	B	—	—	—	—	—
H2	I	B	I/B	I/B	—	—	—	—	—	—

P = Phenol.
2-CP = 2-Chlorophenol.
24-DCP = 2,4-Dichlorophenol.
246-TCP = 2,4,6-Trichlorophenol.
PCP = Pentachlorophenol.
2-NP = 2-Nitrophenol.
4-NP = 4-Nitrophenol.
24-DNP = 2,4-Dinitrophenol.
4-CMC = 4-Chloro-m-cresol (parachlorometa cresol).
24-DMP = 2,4-Dimethylphenol.
R = Raw material.
I = Raw material impurity.
B = Reaction byproduct.
P = Final product.
— = Not likely to be present.

Table V-11. Phenols Detected in Pesticide Process Wastewaters

PHENOLIC PRIORITY POLLUTANTS				
PHENOL				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
C1	1/02	0.27*	(1)	1.8
E1	2/02	0.290†	(3)	28.2
Z1	3/02	0.290†	(3)	28.2
A2	4/02	0.290†	(3)	28.2
H1	5/02	<0.51	(3)	0.022
E1	6/02	16.0*	(21)	0.065
Z1	7/02	47.0*	(1)	0.00002
A2	8/02	47.0*	(1)	0.00002
Y1	9/02	61.8†	(762)	0.124
G1	1/09	0.290†	(3)	28.2
G1	2/09	<1.82*	(3)	0.120
G1	3/09	44.1*	(31)	0.138
G1	4/09	<110*°	(337)	0.20
D2	5/09	<110*°	(337)	0.20
E2	6/09	<110*°	(337)	0.20
G1	7/09	200*°	(312)	0.20
D2	8/09	200*°	(312)	0.20
E2	9/09	200*°	(312)	0.20
G1	10/09	280	(3)	0.015
T1	11/09	1,101†	(22)	0.0035

† = Data from comingled pesticide/other product streams.
* = Data from comingled pesticide streams.
** = Total phenols.
° = Reported as total phenols.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 2 of 7)

PHENOLIC PRIORITY POLLUTANTS				
2-CHLOROPHENOL				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
E1	1/02	0.062†	(3)	28.2
Z1	2/02	0.062†	(3)	28.2
A2	3/02	0.062†	(3)	28.2
E1	4/02	3.00*	(21)	0.065
Z1	5/02	<5.00*	(1)	0.00002
A2	6/02	<5.00*	(1)	0.00002
H1	7/02	30.5	(3)	0.022
Y1	8/02	<1,000	(8)	0.02
G1	1/09	0.062†	(3)	28.2
G1	2/09	<5.09*	(31)	0.138
G1	3/09	11.2*	(3)	0.120

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 3 of 7)

PHENOLIC PRIORITY POLLUTANTS

2,4-DICHLOROPHENOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
C1	1/02	0.042*	(2)	1.8
F2	2/02	0.042*	(2)	1.8
E1	3/02	0.290†	(3)	28.2
Z1	4/02	0.290†	(3)	28.2
A2	5/02	0.290†	(3)	28.2
Z1	6/02	<5.00*	(1)	0.00002
A2	7/02	<5.00*	(1)	0.00002
Q1	8/02	<7.74*	(301)	0.0960
R1	9/02	<7.74*	(301)	0.0960
E1	10/02	15.0*	(21)	0.065
H1	11/02	118	(3)	0.022
Y1	12/02	>1,000	(9)	0.02
V1	13/02	3,000	(1)	0.002
J1	14/02	3,600	(1)	0.00125
V1	15/02	6,650	(6)	0.0034
G1	1/09	0.290†	(3)	28.2
G1	2/09	9.08	(30)	0.101
I1	3/09	36.0	(3)	0.3283
G1	4/09	53.7*	(3)	0.120
G1	5/09	92.2*	(31)	0.138
G1	6/09	42,000	(3)	0.015

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 4 of 7)

PHENOLIC PRIORITY POLLUTANTS

2,4,6-TRICHLOROPHENOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
C1	1/02	0.022*	(2)	1.8
E1	2/02	0.110†	(3)	28.2
Z1	3/02	0.110†	(3)	28.2
A2	4/02	0.110†	(3)	28.2
E1	5/02	3.00*	(21)	0.065
Z1	6/02	<5.00*	(1)	0.00002
A2	7/02	<5.00*	(1)	0.00002
Y1	8/02	<100	(8)	0.02
H1	9/02	481	(3)	0.022
G1	1/09	0.110†	(3)	28.2
G1	2/09	<0.794	(30)	0.101
G1	3/09	2.20*	(3)	0.120
G1	4/09	<3.69*	(31)	0.138
G1	5/09	8,700	(3)	0.015

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 5 of 7)

PHENOLIC PRIORITY POLLUTANTS

PENTACHLOROPHENOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
E1	1/02	1.00*	(21)	0.065
Y1	2/02	>1,000	(9)	0.02

* = Data from comingled pesticide streams.
(n) = Number of data points.

2-NITROPHENOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 6 of 7)

PHENOLIC PRIORITY POLLUTANTS

4-NITROPHENOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
N1	1/02	0.002	(1)	0.006
X1	1/08	174	(121)	0.215
W1	2/08	461*	(610)	0.75
X1	3/08	461*	(610)	0.75

* = Data from comingled pesticide streams.
(n) = Number of data points.

2,4-DINITROPHENOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
M1	1/01	7.91†	(4)	1.06

† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-11. Phenols Detected in Pesticide Process Wastewaters
(Continued, Page 7 of 7)

PHENOLIC PRIORITY POLLUTANTS

PARACHLOROMETA CRESOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

2,4-DIMETHYLPHENOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

4,6-DINITRO-O-CRESOL

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-12. Nitro-Substituted Aromatics Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	NITRO-SUBSTITUTED AROMATIC PRIORITY POLLUTANTS		
	Nitro-benzene	2,4-Dinitrotoluene	2,6-Dinitrotoluene
A1	I,B	--	--
B1	I	--	--
C1	I,B	--	--
D1	I,B	--	--
E1	I,B	--	--
F1	B	B	B
G1	I,B	--	--
H1	B	--	--
I1	B	--	--
J1	I,B	--	--
K1	I,B	--	--
L1	I,B	--	--
M1	--	B	B
N1	I,B	--	--
O1	I	--	--
P1	B	B	B
Q1	I,B	--	--
R1	B	--	--
S1	I,B	B	B
T1	B	B	B
U1	I,B	--	--
V1	I,B	--	--
W1	I	--	--
X1	I,B	--	--
Y1	I,B	--	--
Z1	I	--	--
A2	I,B	--	--

I = Raw material impurity.
B = Reaction byproduct.
-- = Not likely to be present.

Table V-13. Nitro-Substituted Aromatics Detected in Pesticide Process Wastewaters

NITRO-SUBSTITUTED AROMATIC PRIORITY POLLUTANTS				
NITROBENZENE				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
W1	1/02	<0.01	(2)	0.012
B1	1/10	ND*	(1)	NA

NA = Not analyzed.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-13. Nitro-Substituted Aromatics Detected in Pesticide Process Wastewaters (Continued, Page 2 of 2)

NITRO-SUBSTITUTED AROMATIC PRIORITY POLLUTANTS

2,4-DINITROTOLUENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

2,6-DINITROTOLUENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-14. Polynuclear Aromatic Hydrocarbons Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS				
	Naphthalene	2-Chloro-naphthalene	Acenaphthene Acenaphthylene	Anthracene Phenanthrene	Fluorene Fluoranthene
A1	IS	IS,B	--	--	--
B1	I,B	--	I	I	I
C1	IS	IS,B	--	--	--
D1	I,B	B	I	I	I
E1	IS	IS,B	--	--	--
F1	IS	IS,B	--	--	--
G1	IS	IS,B	--	--	--
H1	B	B	--	--	--
I1	IS	IS,B	--	--	--
J1	IS	IS,B	--	--	--
K1	IS	--	--	--	--
L1	IS	IS,B	--	--	--
M1	I,B	B	I	I	I
N1	I,B	--	I	I	I
O1	IS	IS,B	--	--	--
P1	IS	IS,B	--	--	--
Q1	IS	IS,B	--	--	--
R1	I	B	--	--	--
S1	B	B	--	--	--
T1	B	B	--	--	--
U1	IS	IS,B	--	--	--
V1	I	--	I	I	I
W1	IS	--	--	--	--
X1	I,IS	I,B	I	I	I
Y1	IS	--	--	--	--
Pesticide Products Using Benzene	IS	|--See volatiles Table V-2 for specific compounds--|			
Pesticide Products Using Toluene	IS	|--See volatiles Table V-2 for specific compounds--|			

I = Raw material impurity.
B = Reaction byproduct.
IS = Solvent impurity.
-- = Not likely to be present.

Table V-15. Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

NAPHTHALENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
S1	1/02	0.066*	(3)	28.2
T1	2/02	0.066*	(3)	28.2
X1	1/09	ND	(1)	NA
H1	2/09	1.06*	(3)	0.1893

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

2-CHLORONAPHTHALENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
X1	1/09	ND	(1)	NA
H1	2/09	<0.01*	(1)	0.189

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-15. Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters (Continued, Page 2 of 4)

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

ACENAPHTHENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
X1	1/09	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

ACENAPHTHYLENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-15. Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters (Continued, Page 3 of 4)

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

ANTHRACENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
X1	1/09	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

PHENANTHRENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-15. Polynuclear Aromatic Hydrocarbons Detected in Pesticide Process Wastewaters (Continued, Page 4 of 4)

POLYNUCLEAR AROMATIC PRIORITY POLLUTANTS

FLUORENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
X1	1/09	ND	(1)	NA

NA = Not available.
ND = Not detected.
(n) = Number of data points.

FLUORANTHENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-16. Metals Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT METAL								
	Sb	As	Cd	Cr	Cu	Pb	Hg	Ni	Zn
A1	--	I	--	--	--	--	--	--	I
B1	--	--	--	--	--	--	--	--	R
C1	--	--	--	--	C	--	--	--	--
D1	--	--	--	--	C	--	--	--	--
E1	--	--	--	--	C	--	--	--	--
F1	--	--	--	--	C	--	--	--	--
G1	--	--	--	--	C	--	--	--	--
H1	--	--	--	--	C	--	--	--	--
I1	--	--	--	--	C	--	--	--	--
J1	--	--	--	--	C	--	--	--	--
K1	--	--	--	--	--	--	--	--	R
L1	--	--	--	--	--	--	--	--	R
M1	--	--	--	--	R	--	--	--	--
N1	--	--	--	--	--	--	--	--	C
O1	--	--	--	--	C	--	--	C	--
P1	--	--	--	--	C	--	--	--	--
Q1	--	--	--	--	--	--	--	--	R
R1	--	--	--	--	--	--	--	--	R
S1	--	--	--	--	--	--	--	--	R
T1	--	--	--	--	--	--	--	--	R
U1	--	--	--	--	--	--	--	--	R
V1	--	--	--	--	--	--	--	--	R
All the above and other pesticide products	I	I	I	I	I	I	I	I	I

C = Catalyst.
R = Raw material.
I = Impurities in raw materials or catalysts.
-- = Not likely to be present.

Table V-17. Metals Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT METAL

ARSENIC

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/05	2.0	(12)	0.27

COPPER

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
O1	1/01	1.0	(1)	0.03
C1	1/02	ND*	(1)	1.8
C1	2/02	0.05*	(1)	1.8
J1	1/05	ND*	(1)	1.8
M1	2/05	4,500	(325)	0.021
M1	3/05	5,350*	(72)	0.016
G1	4/05	47,000	(1)	0.000946
G1	5/05	59,000	(1)	0.001
F1	1/09	0.204	(3)	1.24

ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-19. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters

CHLORINATED ETHANES AND ETHYLENES

CHLOROETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

1,2-DICHLOROETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
Y1	1/02	ND	(1)	NA
S1	2/02	0.010*	(1)	1.8
S1	3/02	0.37*	(1)	1.8
Z1	4/02	10,000	(3)	0.0002
C1	1/09	0.37*	(1)	1.8
B1	1/10	0.010*	(1)	1.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-19. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 2 of 6)

CHLORINATED ETHANES AND ETHYLENES

1,1-DICHLOROETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
C1	1/09	ND*	(1)	NA
M1	2/09	ND*	(1)	NA
B1	1/10	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

1,1,1-TRICHLOROETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
Y1	1/02	ND	(1)	NA
C1	1/09	ND*	(1)	NA
M1	2/09	ND*	(1)	NA
B1	1/10	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-19. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 3 of 6)

CHLORINATED ETHANES AND ETHYLENES

1,1,2-TRICHLOROETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
S1	1/02	0.020*	(1)	1.8
M1	1/09	0.020*	(1)	1.8

* = Data from comingled pesticide streams.
(n) = Number of data points.

1,1,2,2-TETRACHLOROETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
S1	1/02	1.70*	(1)	1.8
M1	1/09	ND*	(1)	NA
M1	2/09	1.70*	(1)	1.8
B1	1/10	1.70*	(1)	1.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-19. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 4 of 6)

CHLORINATED ETHANES AND ETHYLENES

HEXACHLOROETHANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

VINYL CHLORIDE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-19. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 5 of 6)

CHLORINATED ETHANES AND ETHYLENES

1,1-DICHLOROETHYLENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
M1	1/09	ND*	(1)	NA
C1	2/09	ND*	(1)	NA
B1	1/10	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

1,2-TRANS-DICHLOROETHYLENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-19. Chlorinated Ethanes and Ethylenes Detected in Pesticide Process Wastewaters (Continued, Page 6 of 6)

CHLORINATED ETHANES AND ETHYLENES

TRICHLOROETHYLENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
Y1	1/02	ND*	(1)	NA
M1	1/09	0.052*	(1)	1.8
B1	1/10	0.052*	(1)	1.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

TETRACHLOROETHYLENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
F1	1/02	0.37*	(1)	1.8
U1	2/02	<98.0	(6)	0.00185
N1	1/09	0.467*	(3)	0.1893
Q1	2/09	0.467*	(3)	0.1893

* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-20. Nitrosamines Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT NITROSAMINE		
	N-Nitrosodi-methylamine	N-Nitrosodi-n-propylamine	N-Nitrosodi-phenylamine
A1	B	B	--
B1	--	--	B
C1	B	B	B
D1	B	B	--
E1	B	B	--
F1	B	B	--
G1	B	B	--
H1	B	B	--
I1	B	B	--
J1	B	B	--
K1	B	B	--

B = Reaction byproduct.
-- = Not likely to be present.

Table V-21. Nitrosamines Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT NITROSAMINE

N-NITROSODIMETHYLAMINE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
K1	1/08	0.00005	(240)	0.352

(n) = Number of data points.

N-NITROSODI-N-PROPYLAMINE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
K1	1/08	0.069	(592)	0.076
K1	2/08	0.123	(360)	0.352
K1	3/08	1.85	(3)	0.0678

(n) = Number of data points.

N-NITROSODIPHENYLAMINE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-22. Phthalates Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT PHTHALATE				
	Dimethyl	Diethyl	Di-n-butyl	Butylbenzyl	Bis(2-ethylhexyl)
A1	B	B	B	B	—
B1	B	B	B	B	—
C1	R	I,B	I,B	I,B	—
D1	B	B	B	B	—
E1	R	I,B	I,B	I,B	—
F1	B	B	B	B	—
G1	B	B	B	B	—
H1	B	B	B	B	—
I1	I,B	I,B	I,B	I,B	—
J1	B	B	B	B	—
K1	R	I,B	I,B	I,B	—
Other pesticide products	--	--	--	--	*

* = Not pesticide process-related.
R = Raw material.
I = Raw material impurity.
B = Reaction byproduct.
-- = Not likely to be present.

Table V-23. Phthalate Esters Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT PHTHALATE

DIMETHYL PHTHALATE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

DIETHYL PHTHALATE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
D1	1/01	ND*	(1)	1.8

ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-23. Phthalate Esters Detected in Pesticide Process Wastewaters (Continued, Page 2 of 2)

PRIORITY POLLUTANT PHTHALATE

DI-N-BUTYL PHTHALATE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

BUTYL BENZYL PHTHALATE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

BIS(2-ETHYLHEXYL) PHTHALATE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-24. Dichloropropane and Dichloropropene Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT	
	1,2-Dichloropropane	1,3-Dichloropropene
A1	I,B	I
B1	R	R
C1	B	P
D1	I,B	R
E1	I,B	I,B
F1	I,B	I,B
G1	S	IS,B
H1	B	B
I1	B	B
J1	I	I
K1	B	B
L1	I,B	R
M1	S	IS,B

P = Product.
R = Raw material.
I = Raw material impurity.
S = Solvent.
IS = Solvent impurity.
B = Reaction byproduct.

Table V-25. Dichloropropane and Dichloropropene Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT

1,2-DICHLOROPROPANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
F1	1/09	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

1,3-DICHLOROPROPENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
E1	1/09	ND*	(1)	NA
F1	2/09	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-26. Priority Pollutant Pesticides Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT PESTICIDE											
	Aldrin	Dieldrin	Endosulfan's*	Endosulfan Sulfate	Endrin	Endrin aldehyde	Heptachlor	Heptachlor epoxide	BHC's*	DDT, DDD, DDE	Chlordane	Toxaphene
A1	—	—	—	—	—	—	—	—	P	—	—	—
B1	—	—	—	—	—	—	B	B	—	—	P	—
C1	—	—	—	—	—	—	—	—	—	R,P,B	—	—
D1	—	—	—	—	—	—	—	—	—	R,B,P	—	—
E1	—	—	—	—	—	—	—	—	—	P,B,B	—	—
F1	—	—	—	—	—	—	—	—	—	R,B,B	—	—
G1	—	—	P	B	—	—	—	—	—	—	—	—
H1	B	B	—	—	P	B	—	—	—	—	—	—
I1	—	—	—	—	—	—	P	B	—	—	B	—
J1	—	—	—	—	—	—	—	—	P	—	—	—
K1	—	—	—	—	—	—	—	—	—	B,B,B	—	—
L1	—	—	—	—	—	—	—	—	—	—	—	P
M1	—	—	—	—	—	—	—	—	B	—	—	—

R = Raw material.
P = Product.
B = Reaction byproduct.
— = Not likely to be present.
* = All isomers.
† = Alpha, beta, and delta isomers.

Table V-27. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT PESTICIDE

ALDRIN

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
H1	1/09	0.012*	(3)	0.1893

* = Data from comingled pesticide streams.
(n) = Number of data points.

DIELDRIN

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
H1	1/09	0.382*	(3)	0.1893

* = Data from comingled pesticide streams.
(n) = Number of data points.

ENDOSULFANS--ALL ISOMERS

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

Table V-27. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 2 of 5)

PRIORITY POLLUTANT PESTICIDE				
ENDOSULFAN SULFATE				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

ENDRIN				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
H1	1/09	<0.510	(171)	0.184
H1	2/09	0.518	(3)	0.1893

(n) = Number of data points.

Table V-27. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 3 of 5)

PRIORITY POLLUTANT PESTICIDE

ENDRIN ALDEHYDE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
H1	1/09	ND*	(1)	NA

NA = Not analyzed.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

HEPTACHLOR

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
I1	1/09	0.095	(3)	0.1893
I1	2/09	0.320	(184)	0.184

(n) = Number of data points.

HEPTACHLOR EPOXIDE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
I1	1/09	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-27. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 4 of 5)

PRIORITY POLLUTANT PESTICIDE

BHCs--ALPHA, BETA, AND DELTA ISOMERS

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

4,4'-DDD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
F1*	1/09	<1.54	(16)	NA

NA = Not available.
* = Not presently manufactured.
(n) = Number of data points.

4,4'-DDE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
F1*	1/09	7.34	(16)	NA
E1	2/09	174	(1)	0.0163

NA = Not available.
* = Not presently manufactured.
(n) = Number of data points.

Table V-27. Priority Pollutant Pesticides Detected in Pesticide Process Wastewaters (Continued, Page 5 of 5)

PRIORITY POLLUTANT PESTICIDE

4,4'-DDT

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
F1*	1/09	<0.20	(16)	NA
E1	2/09	135	(1)	0.0163

NA = Not available.
* = Not presently manufactured.
(n) = Number of data points.

CHLORDANE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
I1	1/09	ND*	(1)	NA

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide stream.
(n) = Number of data points.

TOXAPHENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
L1	1/09	0.065°	(4)	1.22
L1	2/09	5.32	(3)	0.0717

° = Analysis not conducted per protocol.
(n) = Number of data points.

Table V-28. Dienes Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	PRIORITY POLLUTANT	
	HCCPD	Hexachlorobutadiene
A1	--	B
B1	--	B
C1	R	I,B
D1	R	I,B
E1	R	I,B
F1	R	I,B
G1	R	I,B
H1	R	I,S

S = Solvent.
R = Raw material.
I = Raw material impurity.
B = Reaction byproduct.
-- = Not likely to be present.
HCCPD = Hexachlorocyclopentadiene.

Table V-29. Dienes Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT

HEXACHLOROCYCLOPENTADIENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
D1	1/05	Trace	(1)	0.000946
D1	2/05	180	(1)	0.001
C1	1/08	2,500†°	(2)	0.10
F1	1/09	0.435*	(50)	0.184
G1	2/09	0.435*	(50)	0.184
F1	3/09	0.827*	(3)	0.1893
G1	4/09	0.827*	(3)	0.1893

* = Data from comingled pesticide streams.
† = Data exceed published solubility of compound in water apparently due to sampling from organic, nonaqueous streams.
° = Attributed to intermediate.
(n) = Number of data points.

HEXACHLOROBUTADIENE

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
F1	1/09	0.191*	(3)	0.1893
G1	2/09	0.191*	(3)	0.1893

* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-30. TCDD Likely to be Present in Pesticide Process Wastewaters

Pesticide Produced	Raw Material	PRIORITY POLLUTANT TCDD
A1	2,4-Dichlorophenol	B
B1	Phenol	B
C1	Phenol	B
D1	2,4-Dichlorophenol	B
E1	2,4-Dichlorophenol	B
F1	2,4,5-Trichlorophenol	B
G1	2,4-Dichlorophenol	B
H1	Phenol	B
I1	2,4,5-Trichlorophenol	B
J1	1,2,4,5-Tetrachlorobenzene	B
K1	1,2,4,5-Tetrachlorobenzene	B

TCDD = 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
B = Reaction byproduct.

Table V-31. TCDD Detected in Pesticide Process Wastewaters

PRIORITY POLLUTANT				
2,3,7,8-TETRACHLORODIBENZO-P-DIOXIN				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
F1	1/02	ND	(E)	0.0031
B1	1/09	<0.000002*	(3)	0.20
J1	2/09	<0.000002*	(3)	0.20
K1	3/09	<0.000002*	(3)	0.20
B1	4/09	0.022*	(1)	0.20
J1	5/09	0.022*	(1)	0.20
K1	6/09	0.022*	(1)	0.20

ND = Not detected.
* = Data from comingled pesticide streams.
(E) = Estimate.
(n) = Number of data points.

Table V-32. Asbestos Detected in Pesticide Process Wastewaters

	PRIORITY POLLUTANT ASBESTOS			
Pesticide Produced	Plant/ Subcategory	Conc. mg/l†	(n)	Flow (MGD)
A1	1/01	ND*	(1)	0.900
B1	2/01	ND*	(1)	8.00
C1	3/01	ND*	(1)	8.00
D1	4/01	ND*	(1)	0.030
E1	5/01	ND*	(1)	8.00
F1	6/01	ND*	(1)	8.00
G1	7/01	0.000038*	(1)	NA
H1	8/01	0.000038*	(1)	NA
I1	9/01	0.0003*	(1)	0.187
J1	10/01	0.000824*	(1)	1.739
K1	11/01	0.000824*	(1)	1.739
L1	12/01	0.0027*	(1)	NA
M1	13/01	0.049*	(1)	33.5
N1	14/01	0.049*	(1)	33.5
A1	1/02	ND*	(1)	8.00
B1	2/02	ND*	(1)	0.960
C1	3/02	ND*	(1)	8.00
D1	4/02	ND*	(1)	0.036
E1	5/02	ND*	(1)	8.00
F1	6/02	ND*	(1)	0.080
G1	7/02	ND*	(1)	0.080
H1	8/02	ND*	(1)	8.00
I1	9/02	ND*	(1)	0.960
J1	10/02	0.000038*	(1)	NA
K1	11/02	0.000185*	(1)	0.030
L1	12/02	0.0003*	(1)	0.187
M1	13/02	0.000824*	(1)	1.739
N1	14/02	0.0027*	(1)	NA
O1	15/02	0.0027*	(1)	NA
P1	16/02	0.0027*	(1)	NA
Q1	17/02	0.003*	(1)	0.187
R1	18/02	0.049*	(1)	33.5
S1	19/02	0.049*	(1)	33.5
T1	20/02	0.049*	(1)	33.5
U1	21/02	0.049*	(1)	33.5
V1	22/02	0.049*	(1)	33.5

Footnotes at end of table

Table V-32. Asbestos Detected in Pesticide Process Wastewaters
(Continued, Page 2 of 3)

Pesticide Produced	Plant/ Subcategory	PRIORITY POLLUTANT ASBESTOS Conc. mg/l†	(n)	Flow (MGD)
W1	23/02	0.049*	(1)	33.5
X1	24/02	0.049*	(1)	33.5
Y1	25/02	0.049*	(1)	33.5
Z1	26/02	0.049*	(1)	33.5
A2	27/02	0.049*	(1)	33.5
B2	28/02	0.049*	(1)	33.5
C2	29/02	0.049*	(1)	33.5
D2	30/02	0.049*	(1)	33.5
E2	31/02	0.3*	(1)	0.100
F2	32/02	0.3*	(1)	0.100
G2	33/02	0.3*	(1)	0.100
H2	34/02	0.3*	(1)	0.100
I2	35/02	0.3*	(1)	0.100
J2	36/02	0.3*	(1)	0.100
A1	1/03	0.0027*	(1)	NA
A1	1/04	ND*	(1)	0.960
A1	1/05	0.000038*	(1)	NA
B1	2/05	0.000038*	(1)	NA
C1	3/05	0.000038*	(1)	NA
A1	1/08	ND*	(1)	0.900
B1	2/08	ND*	(1)	8.00
A1	1/09	ND*	(1)	0.080
B1	2/09	ND*	(1)	0.960
C1	3/09	ND*	(1)	0.036
D1	4/09	ND*	(1)	0.083
E1	5/09	0.00093*	(1)	1.90
F1	6/09	0.00093*	(1)	1.90
G1	7/09	0.0027*	(1)	NA
H1	8/09	0.0027*	(1)	NA
I1	9/09	0.049*	(1)	33.5

Footnotes at end of table

Table V-32. Asbestos Detected in Pesticide Process Wastewaters
(Continued, Page 3 of 3)

Pesticide Produced	Plant/ Subcategory	PRIORITY POLLUTANT ASBESTOS Conc. mg/l†	(n)	Flow (MGD)
J1	10/09	0.049*	(1)	33.5
K1	11/09	0.049*	(1)	33.5
L1	12/09	0.3*	(1)	0.100
M1	13/09	0.3*	(1)	0.100
N1	14/09	0.3*	(1)	0.100
A1	1/10	ND*	(1)	0.960
B1	2/10	ND*	(1)	0.900
C1	3/10	ND*	(1)	0.960
D1	4/10	ND*	(1)	0.960
E1	5/10	ND*	(1)	0.960
F1	6/10	ND*	(1)	0.960
G1	7/10	ND*	(1)	0.960
H1	8/10	ND*	(1)	0.960
I1	9/10	ND*	(1)	0.960
J1	10/10	ND*	(1)	0.960
K1	11/10	0.0003*	(1)	0.187

NA = Not available.
ND = Not detected.
* = Data from comingled wastewater.
† = Total calculated mass chrysotile fibers only. Maximum of all plant averages reported.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters

NONCONVENTIONAL PARAMETERS

PESTICIDES

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/01	ND*	(11)	0.405
B1	2/01	ND	(1)	0.000002
C1	3/01	ND	(E)	0.00005
D1	4/01	None	(E)	0.0048
E1	5/01	None	(E)	0.0048
F1	6/01	None	(E)	0.0004
G1	7/01	0.003	(1)	0.101
H1	8/01	<0.0336	(25)	1.8
I1	9/01	1.60	(8)	1.15
J1	10/01	3.32*	(3)	1.88
K1	11/01	3.49	(10)	NA
L1	12/01	7.57	(5)	0.0315
M1	13/01	8.03°*	(18)	0.0923
N1	14/01	10.4	(221)	1.08
O1	15/01	10.9	(4)	1.224
P1	16/01	16.0**	(1)	0.03
Q1	17/01	41.8	(147)	0.242
R1	18/01	160	(3)	0.00323
S1	19/01	430	(3)	0.187
T1	20/01	477	(163)	0.006
U1	21/01	720	(1)	0.01
V1	22/01	747	(1)	0.0451
W1	23/01	1,090	(2)	0.0072
X1	24/01	3,000	(E)	0.022
Y1	25/01	4,320	(150)	0.005
Z1	26/01	5,995	(E)	0.00020
W1	27/01	6,478	(1)	0.00281
X1	28/01	6,800	(1)	0.0034
Y1	29/01	11,200	(690)	0.005
A1	1/02	NA	(180)	0.012
B1	2/02	ND	(1)	0.000002
C1	3/02	0.000953	(29)	0.8

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
° = Analyzed as hydrolysis product.
** = Average of pilot plant data.
(E) = Estimate.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 2 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
D1	4/02	<0.019	(10)	1.8
E1	5/02	<0.0817	(105)	1.8
F1	6/02	<0.0918	(33)	1.8
G1	7/02	<0.159	(7)	1.8
H1	8/02	0.175	(2)	0.00854
I1	9/02	<0.189	(18)	1.8
J1	10/02	0.207	(2)	2.3
K1	11/02	0.240	(4)	28.2
L1	12/02	0.439	(20)	1.8
M1	13/02	0.470†	(3)	28.2
N1	14/02	0.527	(8)	0.130
O1	15/02	0.58†	(4)	0.09425
P1	16/02	0.615	(3)	1.241
Q1	17/02	0.70	(11)	3.6
R1	18/02	<0.850	(59)	1.8
S1	19/02	1.08	(1)	0.144
T1	20/02	1.10†	(3)	28.2
U1	21/02	1.54	(6)	3.6
V1	22/02	2.00	(E)	0.161
W1	23/02	2.5	(9)	3.6
X1	24/02	3.0†	(3)	28.2
Y1	25/02	4.26	(365)	1.034
Z1	26/02	6.30	(173)	0.104
A2	27/02	7.75	(1)	0.0202
B2	28/02	9.0	(22)	0.00156
C2	29/02	13.2	(365)	1.034
D2	30/02	14.4	(89)	1.034
E2	31/02	15.0	(2)	0.012
F2	32/02	17.0	(449)	0.135
G2	33/02	19.9	(3)	2.3
H2	34/02	25.8*	(2)	0.0749
I2	35/02	29.1	(1)	0.144
J2	36/02	30.3	(30)	0.0792

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 3 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
K2	37/02	36*	(47)	0.094
L2	38/02	45.9	(3)	1.241
M2	39/02	53.8	(2)	0.0086
N2	40/02	71.1††	(125)	0.08026
O2	41/02	85*	(111)	0.094
P2	42/02	93.1	(11)	0.08026
Q2	43/02	104	(570)	0.0634
R2	44/02	127*	(111)	0.094
S2	45/02	135*	(111)	0.094
T2	46/02	136	(30)	0.2088
U2	47/02	<152††	(150)	0.08026
V2	48/02	174	(173)	0.104
W2	49/02	212	(1)	0.145
X2	50/02	218	(5)	0.0315
Y2	51/02	260	(2)	0.022
Z2	52/02	300	(1)	0.30
A3	53/02	320	(13)	0.208
B3	54/02	335	(3)	0.154
C3	55/02	600	(E)	4,140 gal/ 1,000 lbs
D3	56/02	863*	(1)	0.144
E3	57/02	863*	(1)	0.144
F3	58/02	863*	(1)	0.144
G3	59/02	863*	(1)	0.144
H3	60/02	863*	(1)	0.144
I3	61/02	973	(30)	0.792
J3	62/02	1,100	(474)	0.1633
K3	63/02	1,290	(12)	0.163
L3	64/02	1,630	(180)	0.012
M3	65/02	1,778	(5)	NA
N3	66/02	2,600	(1)	0.0086
O3	67/02	3,460	(3)	0.0181
P3	68/02	3,586	(2)	0.00125
Q3	69/02	4,580	(210)	0.008
R3	70/02	5,500*	(1)	0.00002
S3	71/02	5,500*	(1)	0.00002

NA = Not available.
* = Data from comingled pesticide streams.
†† = Values reported are after pretreatment.
(E) = Estimate.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 4 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/03	6.9	(13)	3.6
B1	2/03	6.9	(E)	3.6
C1	3/03	481	(E)	9,150 gal/ 1,000 lbs
A1	1/04	12.2	(7)	1.23
B1	2/04	<23.5	(72)	1.42
C1	3/04	60.0	(1)	1.5
D1	4/04	<1,418	(4)	0.10
A1	1/05	Trace	(1)	0.000946
B1	2/05	<0.820	(23)	1.8
C1	3/05	25.8*	(2)	0.0749
D1	4/05	25.8*	(2)	0.0749
E1	5/05	863*	(1)	0.144
A1	1/08	12.2*	(606)	0.75
B1	2/08	12.2*	(606)	0.75
C1	3/08	14.8	(3)	0.0678
D1	4/08	26.8	(14)	0.06
E1	5/08	27	(85)	0.05
F1	6/08	184	(26)	0.081
G1	7/08	5,950	(690)	0.010
A1	1/09	0.00846	(3)	1.241
B1	2/09	<0.010	(3)	0.1027
C1	3/09	0.065°	(4)	1.224
D1	4/09	0.095	(3)	0.1893
E1	5/09	0.2	(4)	28.2
F1	6/09	0.320	(184)	0.184
G1	7/09	0.457	(2)	0.0033
H1	8/09	<0.510	(171)	0.184
I1	9/09	0.518	(3)	0.1893
J1	10/09	<0.753	(120)	1.8
K1	11/09	1.48	(3)	2.3

* = Data from comingled pesticide streams.
° = Analysis not conducted per protocol.
(E) = Estimate.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 5 of 11)

NONCONVENTIONAL PARAMETERS

PESTICIDES

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
L1	12/09	<2.00	(1)	2.3
M1	13/09	<3.02	(75)	1.8
N1	14/09	5.32	(3)	0.0717
O1	15/09	15.5	(25)	505 gal/ 1,000 lbs
P1	16/09	17.2	(17)	117 gal/ 1,000 lbs
Q1	17/09	32.3	(1)	0.20
R1	18/09	49.7	(1)	0.20
S1	19/09	66.5	(1)	0.20
T1	20/09	82.5	(28)	0.138
U1	21/09	83.0	(3)	0.120
V1	22/09	190	(2)	0.0163
W1	23/09	228	(2)	0.0163
X1	24/09	326	(1)	0.042
Y1	25/09	330	(3)	0.3283
Z1	26/09	535	(30)	0.101
A2	27/09	9,300	(3)	0.015
A1	1/10	<0.01	(26)	1.8
B1	2/10	<3.58	(80)	1.8
C1	3/10	<4.93	(49)	1.42
D1	4/10	<6.32	(28)	1.42
E1	5/10	<6.64	(22)	1.42
F1	6/10	<7.67	(9)	1.42
G1	7/10	<8.51	(41)	1.42
H1	8/10	<15.8	(28)	1.42
I1	9/10	<17.7	(87)	1.42
J1	10/10	18.1	(4)	1.224
K1	11/10	40.7	(154)	1.01
L1	12/10	45.7*	(540)	2.5
M1	13/10	45.7*	(540)	2.5
N1	14/10	45.7*	(540)	2.5
O1	15/10	83.4	(3)	0.0634
P1	16/10	133*	(270)	1.3
Q1	17/10	133*	(270)	1.3
R1	18/10	133*	(270)	1.3

* = Data from comingled pesticide streams.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 6 of 11)

NONCONVENTIONAL PARAMETERS

COD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/01	<100.0†**	(1)	NA
B1	2/01	431*	(3)	0.110
C1	3/01	895*	(3)	1.22
D1	4/01	2,750†	(3)	1.88
E1	5/01	2,750†	(3)	1.88
F1	6/01	2,830†	(1)	2.01
G1	7/01	2,830†	(1)	2.01
H1	8/01	4,500†**	(1)	NA
I1	9/01	4,750*	(5)	0.0315
J1	10/01	5,800	(8)	0.106
K1	11/01	7,070*	(59)	1,900 gal/ 1,000 lbs
L1	12/01	8,120	(E)	1,200 gal/ 1,000 lbs
M1	13/01	14,400	(1)	0.0013
N1	14/01	17,000*	(E)	0.02
O1	15/01	17,000*	(E)	0.02
P1	16/01	17,000*	(E)	0.02
Q1	17/01	18,900*	(12)	0.105
R1	18/01	22,650	(1)	0.0034
S1	19/01	23,900	(E)	774 gal/ 1,000 lbs
T1	20/01	150,000†	(1)	0.018
U1	21/01	150,000†	(1)	0.018
V1	22/01	1,220,000	(E)	156 gal/ 1,000 lbs
A1	1/02	14.0*	(1)	NA
B1	2/02	14.0*	(1)	NA
C1	3/02	360	(449)	0.135
D1	4/02	431*	(3)	0.110
E1	5/02	711*	(E)	8,000 gal/ 1,000 lbs
F1	6/02	711*	(E)	8,000 gal/ 1,000 lbs

NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
** = Pilot plant data average.
(E) = Estimate.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 7 of 11)

NONCONVENTIONAL PARAMETERS

COD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
G1	7/02	711*	(E)	8,000 gal/ 1,000 lbs
H1	8/02	1,318*	(365)	1.034
I1	9/02	1,318*	(365)	1.034
J1	10/02	1,320*	(365)	1.034
K1	11/02	1,660†	(3)	2.3
L1	12/02	1,660†	(3)	2.3
M1	13/02	1,660†	(3)	2.3
N1	14/02	1,710	NA	0.2088
O1	15/02	2,190†	(421)	0.124
P1	16/02	2,450	(1)	0.018
Q1	17/02	3,340*	(3)	0.1027
R1	18/02	3,710	(30)	0.792
S1	19/02	4,750*	(5)	0.0315
T1	20/02	4,900	(1)	0.010
U1	21/02	5,250	(1)	0.09
V1	22/02	5,250	(73)	0.1633
W1	23/02	5,700	NA	0.0792
X1	24/02	5,870†	(3)	1.241
Y1	25/02	5,870†	(3)	1.241
Z1	26/02	7,070*	(59)	1,900 gal/ 1,000 lbs
A2	27/02	7,070*	(59)	1,900 gal/ 1,000 lbs
B2	28/02	7,070*	(59)	1,900 gal/ 1,000 lbs
C2	29/02	7,070*	(59)	1,900 gal/ 1,000 lbs
D2	30/02	14,000	(3)	0.048
E2	31/02	16,000	(E)	1,200 gal/ 1,000 lbs
F2	32/02	16,800	NA	0.0634
G2	33/02	28,000†	(3)	0.0181
H2	34/02	40,000	(1)	0.30

NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 8 of 11)

NONCONVENTIONAL PARAMETERS

COD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
I2	35/02	75,500†	(1)	0.0202
J2	36/02	150,000†	(1)	0.018
K2	37/02	150,000†	(1)	0.018
L2	38/02	195,000	(E)	4,718 gal/ 1,000 lbs
A1	1/03	1,570	(E)	9,150 gal/ 1,000 lbs
A1	1/04	17,000*	(E)	0.02
A1	1/05	7,070*	(59)	1,900 gal/ 1,000 lbs
A1	1/08	436*	(606)	0.7224
B1	2/08	436*	(606)	0.7224
C1	3/08	5,109	(3)	0.0678
D1	4/08	9,740	(375)	0.213
E1	5/08	150,000†	(1)	0.018
A1	1/09	594	(3)	0.0717
B1	2/09	674*	(3)	0.1893
C1	3/09	674*	(3)	0.1893
D1	4/09	1,610	(3)	0.0033
E1	5/09	1,660†	(3)	2.3
F1	6/09	3,340*	(3)	0.1027
G1	7/09	3,340*	(3)	0.1027
H1	8/09	5,870†	(3)	1.241
I1	9/09	7,070*	(59)	1,900 gal/ 1,000 lbs
J1	10/09	7,070*	(59)	1,900 gal/ 1,000 lbs
K1	11/09	18,900*	(12)	0.105
L1	12/09	148,000	(6)	117 gal 1,000 lbs

NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 9 of 11)

NONCONVENTIONAL PARAMETERS

COD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/10	353*	(270)	1.3
B1	2/10	353*	(270)	1.3
C1	3/10	353*	(270)	1.3
D1	4/10	468*	(540)	2.5
E1	5/10	468*	(540)	2.5
F1	6/10	468*	(540)	2.5
G1	7/10	895*	(3)	1.22
H1	8/10	5,870†	(3)	1.241
I1	9/10	17,444	(1)	0.0634

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 10 of 11)

NONCONVENTIONAL PARAMETERS				
TOC				
Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/01	900†	(1)	2.01
B1	2/01	900†	(1)	2.01
C1	3/01	1,650*	(5)	0.0315
D1	4/01	4,420†	(3)	1.88
E1	5/01	4,420†	(3)	1.88
F1	6/01	5,850*	(12)	0.105
G1	7/01	11,400†	(19)	0.01
H1	8/01	50,000†	(1)	0.018
I1	9/01	50,000†	(1)	0.018
A1	1/02	122*	(47)	0.551
B1	2/02	1,650*	(5)	0.0315
C1	3/02	1,810†	(3)	1.241
D1	4/02	1,810†	(3)	1.241
E1	5/02	3,230	(503)	0.1633
F1	6/02	19,500†	(1)	0.0202
G1	7/02	28,500†	(3)	0.0181
H1	8/02	50,000†	(1)	0.018
I1	9/02	50,000†	(1)	0.018
A1	1/04	122*	(47)	0.551
B1	2/04	523*	(469)	0.15
A1	1/08	50,000†	(1)	0.018
A1	1/09	53.2	(3)	0.0717
B1	2/09	341*	(3)	0.1893
C1	3/09	341*	(3)	0.1893
D1	4/09	441	(3)	0.0033
E1	5/09	1,810†	(3)	1.241
F1	6/09	2,660*	(3)	0.243
G1	7/09	5,850*	(12)	0.105
H1	8/09	79,800	(6)	117 gal/ 1,000 lbs

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-33. Nonconventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 11 of 11)

NONCONVENTIONAL PARAMETERS

TOC

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/10	178*	(540)	2.5
B1	2/10	178*	(540)	2.5
C1	3/10	178*	(540)	2.5
D1	4/10	585*	(270)	1.3
E1	5/10	585*	(270)	1.3
F1	6/10	585*	(270)	1.3
G1	7/10	1,810†	(3)	1.241

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

TOD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
No data available.				

able V-34. Conventional Parameters Detected in Pesticide Process Wastewaters

CONVENTIONAL PARAMETERS

BOD

›esticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/01	<103	(3)	0.00323
B1	2/01	103*	(3)	0.110
C1	3/01	120†	(3)	28.2
D1	4/01	137*	(3)	1.22
E1	5/01	572	(8)	0.106
F1	6/01	791†	(2)	1.88
G1	7/01	791†	(2)	1.88
H1	8/01	2,000†**	(1)	NA
I1	9/01	2,260*	(14)	1,900 gal/ 1,000 lbs
J1	10/01	2,450	(E)	1,200 gal/ 1,000 lbs
K1	11/01	3,490	(1)	0.0034
L1	12/01	6,600*	(12)	0.105
M1	13/01	16,000	(1)	0.0013
N1	14/01	60,000†	(1)	0.018
O1	15/01	60,000†	(1)	0.018
A1	1/02	103*	(3)	0.110
B1	2/02	120†	(3)	28.2
C1	3/02	120†	(3)	28.2
D1	4/02	120†	(3)	28.2
E1	5/02	120†	(3)	28.2
F1	6/02	120†	(3)	28.2
G1	7/02	120†	(3)	28.2
H1	8/02	120†	(3)	28.2
I1	9/02	179*	(41)	0.551
J1	10/02	355*	(E)	8,000 gal/ 1,000 lbs
K1	11/02	355*	(E)	8,000 gal/ 1,000 lbs
L1	12/02	355*	(E)	8,000 gal/ 1,000 lbs
M1	13/02	610†	(4)	2.3

NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
** = Pilot plant data average.
(E) = Estimate.
(n) = Number of data points.

Table V-34. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 2 of 7)

CONVENTIONAL PARAMETERS

BOD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
N1	14/02	610†	(4)	2.3
O1	15/02	610†	(4)	2.3
P1	16/02	630*	(202)	1.034
Q1	17/02	630*	(202)	1.034
R1	18/02	630*	(202)	1.034
S1	19/02	1,000	(1)	0.018
T1	20/02	1,940†	(3)	1.241
U1	21/02	1,940†	(3)	1.241
V1	22/02	2,000	(1)	0.010
W1	23/02	2,260*	(14)	1,900 gal/ 1,000 lbs
X1	24/02	2,260*	(14)	1,900 gal/ 1,000 lbs
Y1	25/02	2,260*	(14)	1,900 gal/ 1,000 lbs
Z1	26/02	2,260*	(14)	1,900 gal/ 1,000 lbs
A2	27/02	3,330†	(2)	0.0181
B2	28/02	3,500	(1)	0.30
C2	29/02	4,840†	(E)	4,140 gal/ 1,000 lbs
D2	30/02	5,680*††	(3)	0.1027
E2	31/02	7,200	(3)	0.048
F2	32/02	8,500	(E)	1,200 gal/ 1,000 lbs
G2	33/02	19,600†	(E)	4,140 gal/ 1,000 lbs
H2	34/02	60,000†	(1)	0.018
I2	35/02	60,000†	(1)	0.018
A1	1/03	703	(E)	9,150 gal/ 1,000 lbs

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
†† = Values reported are after pretreatment.
(E) = Estimate.
(n) = Number of data points.

Table V-34. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 3 of 7)

CONVENTIONAL PARAMETERS

BOD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/04	179*	(41)	0.551
B1	2/04	2,082†	(756)	1.42
A1	1/05	2,260*	(14)	1,900 gal/ 1,000 lbs
A1	1/08	4,320	(85)	0.213
B1	2/08	60,000†	(1)	0.018
A1	1/09	58.2	(3)	0.0717
B1	2/09	120†	(3)	28.2
C1	3/09	331*	(3)	0.1893
D1	4/09	331*	(3)	0.1893
E1	5/09	610†	(4)	2.3
F1	6/09	1,940†	(3)	0.084
G1	7/09	1,940†	(3)	1.241
H1	8/09	2,260*	(14)	1,900 gal/ 1,000 lbs
I1	9/09	2,260*	(14)	1,900 gal/ 1,000 lbs
J1	10/09	5,680*	(3)	0.1027
K1	11/09	5,680*	(3)	0.1027
L1	12/09	6,600*	(12)	0.105
M1	13/09	45,200	(6)	117 gal/ 1,000 lbs
A1	1/10	ND*	(270)	1.3
B1	2/10	ND*	(270)	1.3
C1	3/10	ND*	(270)	1.3
D1	4/10	137*	(3)	1.22
E1	5/10	300	(1)	0.0634
F1	6/10	1,940†	(3)	1.241
G1	7/10	2,082†	(756)	1.42
H1	8/10	2,082†	(756)	1.42
I1	9/10	2,082†	(756)	1.42

ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-34. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 4 of 7)

CONVENTIONAL PARAMETERS

BOD

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
J1	10/10	2,082†	(756)	1.42
K1	11/10	2,082†	(756)	1.42
L1	12/10	2,082†	(756)	1.42
M1	13/10	2,082†	(756)	1.42

† = Data from comingled pesticide/other product streams.
(n) = Number of data points.

Table V-34. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 5 of 7)

CONVENTIONAL PARAMETERS

TSS

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
A1	1/01	59.0†	(3)	28.2
B1	2/01	69.0*	(3)	0.110
C1	3/01	87.7	(3)	0.00323
D1	4/01	110	(146)	0.242
E1	5/01	143†	(3)	1.88
F1	6/01	143†	(3)	1.88
G1	7/01	181	(E)	1,200 gal/ 1,000 lbs
H1	8/01	246*	(37)	1,900 gal/ 1,000 lbs
I1	9/01	340†	(1)	2.01
J1	10/01	340†	(1)	2.01
K1	11/01	350	(8)	0.106
L1	12/01	750	(1)	0.0034
A1	1/02	2.00*	(1)	NA
B1	2/02	2.00*	(1)	NA
C1	3/02	3.00†	(3)	2.3
D1	4/02	3.00†	(3)	2.3
E1	5/02	3.00†	(3)	2.3
F1	6/02	32.8*	(365)	1.034
G1	7/02	32.8*	(365)	1.034
H1	8/02	32.8*	(365)	1.034
I1	9/02	37.3	NA	0.2088
J1	10/02	68.6*	(5)	0.0315
K1	11/02	56.6*††	(3)	0.1027
L1	12/02	59.0†	(3)	28.2
M1	13/02	59.0†	(3)	28.2
N1	14/02	59.0†	(3)	28.2
O1	15/02	59.0†	(3)	28.2
P1	16/02	59.0†	(3)	28.2
Q1	17/02	59.0†	(3)	28.2
R1	18/02	59.0†	(3)	28.2

NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
†† = Values reported are after pretreatment.
(E) = Estimate.
(n) = Number of data points.

Table V-34. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 6 of 7)

CONVENTIONAL PARAMETERS

TSS

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
S1	19/02	69.0*	(3)	0.110
T1	20/02	78.0	(30)	0.792
U1	21/02	100	(1)	0.010
V1	22/02	124	(1)	0.0792
W1	23/02	246*	(37)	1,900 gal/ 1,000 lbs
X1	24/02	246*	(37)	1,900 gal/ 1,000 lbs
Y1	25/02	246*	(37)	1,900 gal/ 1,000 lbs
Z1	26/02	246*	(37)	1,900 gal/ 1,000 lbs
A2	27/02	269†	(3)	1.241
B2	28/02	269†	(3)	1.241
C2	29/02	300	(1)	0.018
D2	30/02	3,000†	(1)	0.0202
E2	31/02	3,800*	(E)	8,000 gal/ 1,000 lbs
F2	32/02	3,800*	(E)	8,000 gal/ 1,000 lbs
G2	33/02	3,800*	(E)	8,000 gal/ 1,000 lbs
H2	34/02	4,090	(3)	0.0181
A1	1/03	1,720	(E)	9,150 gal/ 1,000 lbs
A1	1/04	375†	(73)	1.42
A1	1/05	246*	(37)	1,900 gal/ 1,000 lbs
AI	1/08	141	(30)	0.352
B1	2/08	360	(12)	1,510 gal/ 1,000 lbs

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(E) = Estimate.
(n) = Number of data points.

Table V-34. Conventional Parameters Detected in Pesticide Process Wastewaters (Continued, Page 7 of 7)

CONVENTIONAL PARAMETERS

TSS

Pesticide Produced	Plant/ Subcategory	Conc. mg/l	(n)	Flow (MGD)
C1	3/08	407	(1)	NA
A1	1/09	3.00†	(3)	2.3
B1	2/09	56.6*	(3)	0.1027
C1	3/09	56.6*	(3)	0.1027
D1	4/09	59.0†	(3)	28.2
E1	5/09	208*°°	(3)	0.1893
F1	6/09	208*°°	(3)	0.1893
G1	7/09	226	(3)	0.0033
H1	8/09	246*	(37)	1,900 gal/ 1,000 lbs
I1	9/09	246*	(37)	1,900 gal/ 1,000 lbs
J1	10/09	269†	(3)	1.241
K1	11/09	1,460	(6)	117 gal/ 1,000 lbs
L1	12/09	2,720	(3)	0.0717
A1	1/10	253*	(530)	2.5
B1	2/10	253*	(530)	2.5
C1	3/10	253*	(530)	2.5
D1	4/10	269†	(3)	1.241
E1	5/10	375†	(73)	1.42
F1	6/10	375†	(73)	1.42
G1	7/10	375†	(73)	1.42
H1	8/10	375†	(73)	1.42
I1	9/10	375†	(73)	1.42
J1	10/10	375†	(73)	1.42
K1	11/10	375†	(73)	1.42
L1	12/10	411*	(270)	1.3
M1	13/10	411*	(270)	1.3
N1	14/10	411*	(270)	1.3
O1	15/10	474	(1)	0.0634

NA = Not available.
† = Data from comingled pesticide/other product streams.
* = Data from comingled pesticide streams.
°° = Post pretreatment.
(n) = Number of data points.

Table V-35. Summary of Raw Waste Load Design Levels

Pollutant Group	Design Level (mg/l)	Percent of Detected Pesticide Wastewaters at Design Level*
Volatile Aromatics	127-293,000	24
Halomethanes	122-2,600	23
Cyanides	5,503	6.0
Haloethers	0.582	17
Phenols	100-42,000	45
Nitro-Substituted Aromatics	ND	100
Polynuclear Aromatics	1.06-1.2	25
Metals--Copper	4,500	17
--Zinc	247	100
Chlorinated Ethanes & Ethylenes	98-10,000	18
Nitrosamines	1.96	100
Phthalates	ND	100
Dichloropropane & Dichloropropene	ND	100
Pesticides	10-11,200	45
Dienes	2,500-15,000	50
TCDD	0.022	100
Miscellaneous	N/A	N/A
PCBs	N/A	N/A
Benzidine	N/A	N/A
BOD	1,470†	33
COD	3,886†	45
TSS	266†	14

N/A = Not applicable.
ND = Not detected.
* = Remainder of detected pesticide wastewaters are below design level.
† = Prior to biological oxidation.

Table V-36. Plants Manufacturing Pesticides With No Process Wastewater Discharge*

Plant Code	Pesticide	Comment
1	2,4-D dimethyl amine salt	No Wastewater Generated
	2,4-D isooctyl ester	No Wastewater Generated
	Silvex dimethyl amine salt	No Wastewater Generated
	Silvex isooctyl ester	No Wastewater Generated
2	Pyrethrins	No Wastewater Generated
3	Ethoprop	Wastewater Evaporated
	Merphos	Wastewater Evaporated
4	Amobam	No Wastewater Generated
	Fluoroacetamide	No Wastewater Generated
	Sodium monofluoroacetate	No Wastewater Generated
5	Metasol J-26	No Wastewater Generated
6	Chloropicrin	Recycle/Reuse
7	Dichloroethyl ether	Wastewater Evaporated
	HPMTS	Wastewater Evaporated
8	Vancide 51Z	No Wastewater Generated
	Vancide 51Z dispersion	No Wastewater Generated
	Vancide TH	No Wastewater Generated
	Ziram	No Wastewater Generated
9	Glyodin	No Wastewater Generated
10	Dichlorophen salts	No Wastewater Generated
11	D-D	No Wastewater Generated
	Dichloropropene	No Wastewater Generated
12	D-D	Recycle/Reuse

Footnotes at end of table

Table V-36. Plants Manufacturing Pesticides With No Process Wastewater Discharge* (Continued, Page 2 of 2)

Plant Code	Pesticide	Comment
13	Barban	Wastewater Evaporated
14	Alkylamine hydrochloride	No Wastewater Generated
	BBTAC	No Wastewater Generated
	Tributyltin benzoate	No Wastewater Generated
15	Chloropicrin	Recycle/Reuse
16	Chloropicrin	Recycle/Reuse
	Dowicil 75	Wastewater Evaporated
17	D-D	No Wastewater Generated
	Dichloropropene	No Wastewater Generated
	Biphenyl	Wastewater Incinerated
18	Tributyltin oxide	No Wastewater Generated

* = "No process wastewater discharge" can be accomplished via recycle/reuse, evaporation, incineration, or if no wastewater is generated.

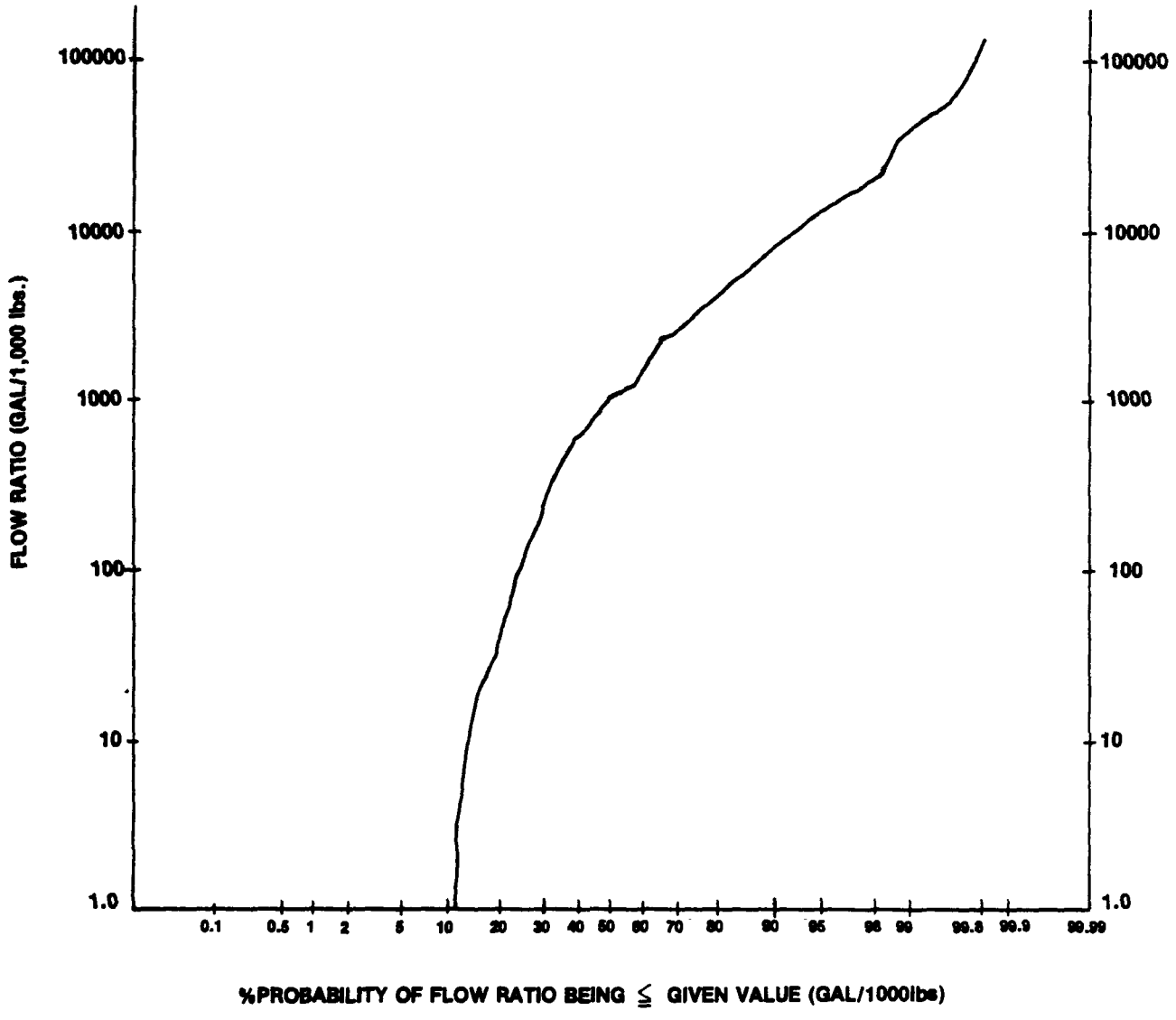


FIGURE V-1 PROBABILITY PLOT OF PESTICIDE PRODUCT FLOW RATIOS

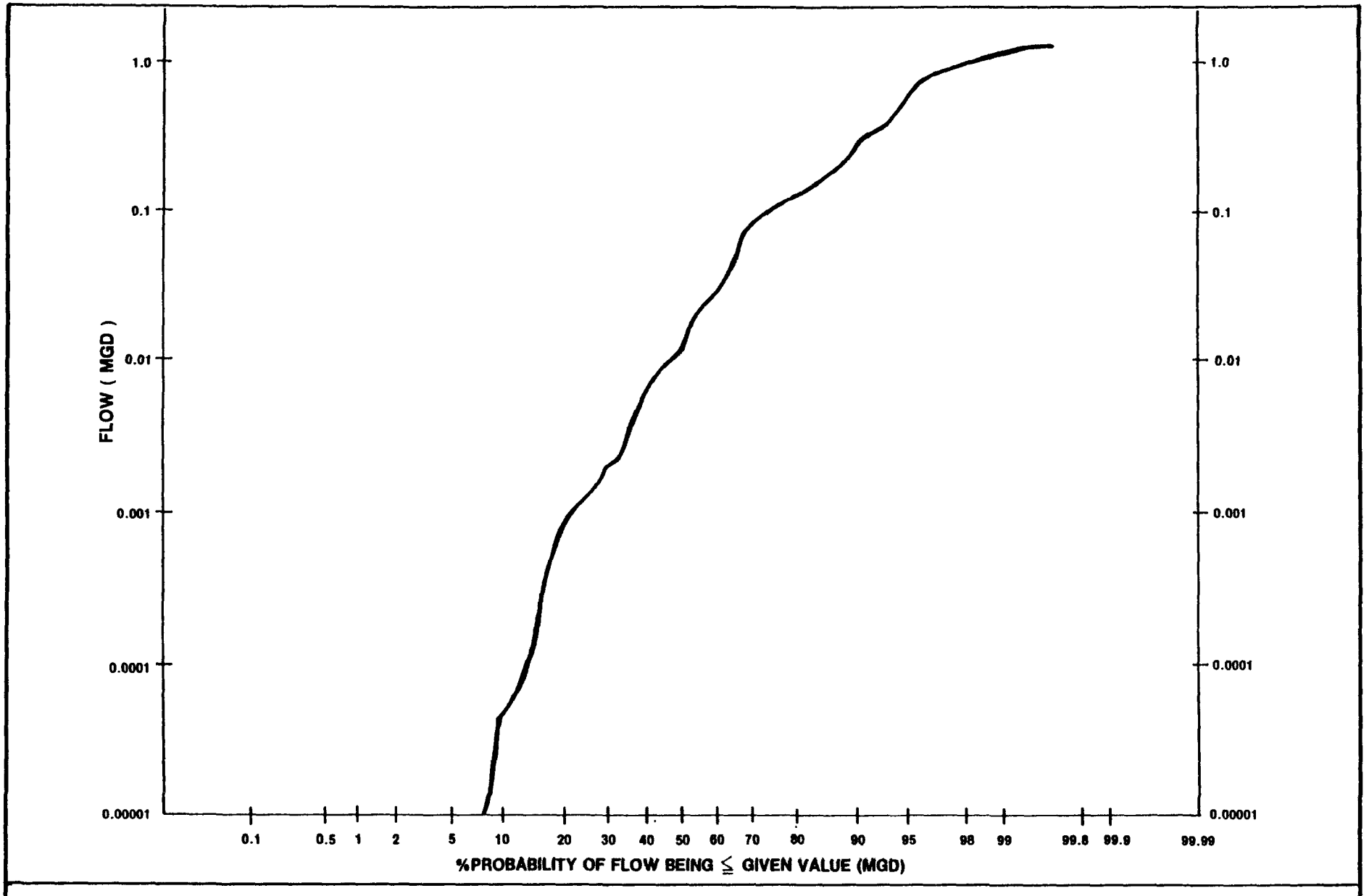


FIGURE V-2 PROBABILITY PLOT OF PESTICIDE PRODUCT FLOWS

SECTION VI

CONTROL AND TREATMENT TECHNOLOGY

This section identifies potential in-plant and end-of-pipe control and treatment technologies for the removal of conventional, nonconventional, and priority pollutants. The effectiveness of potential technologies is evaluated, and recommended unit treatments are specified. Design criteria and flow diagrams for the recommended unit treatments are presented.

The specific technologies recommended herein represent only one of several methods for the effective removal of the pollutants under consideration. Wastewater monitoring and treatability studies should be conducted for a particular facility in order to determine the most cost-effective employment and design of available technologies. The systems designed and costed for this study were derived from comparisons with full-scale treatment units in the industry. The installation of similarly designed and properly operated systems is expected to result in the attainment of equivalent effluent levels.

IN-PLANT CONTROL

The first and most cost-effective step which can be taken to reduce wastewater pollutants is to treat them at the source. The following discussion addresses techniques which have general application throughout the industry.

Waste segregation is an important step in waste reduction. As demonstrated by plants such as Plants 1, 2, 3, 4, 5, and others, process wastewaters containing specific priority pollutants can often be isolated and disposed or treated separately in a more technically efficient and economical manner than in combined flows. Highly acidic and caustic wastewater is usually more effectively adjusted for pH prior to being mixed with other wastes. Separate equalization for streams of highly variable characteristics is utilized by more than 41 plants to improve overall treatment efficiency.

Water reduction can be achieved by replacing steam jet eductors and barometric condensors with vacuum pumps and surface condensers such as has been accomplished by Plant 6. Reuse or recycle can be applied to reactor and floor washwater, surface runoff, scrubber effluents, and vacuum seal water as demonstrated by Plant 7. Reboilers can be used instead of live steam.

A good housekeeping and wastewater monitoring program can effect considerable reductions. Flow measuring devices and pH sensors can be adapted with automatic alarms such as at Plant 8 in order to detect

process upsets. Dry clean-up of spills can be used instead of washing into floor drains as is demonstrated in the formulation and packaging portion of the industry. Prompt repair and replacement of faulty equipment can reduce waste losses.

Material recovery can be achieved through solvent extraction, steam stripping, and distillation operations as reported at Plants 9 and 10. Dilute streams can be concentrated in evaporators and then recovered as reported by Plant 11. Water-based reactions can be conducted in solvents assuming that subsequent recovery is practiced as reported by Plant 12.

Specific pollutants can be reduced by requesting specification changes from raw material suppliers in cases where impurities are present.

TREATMENT TECHNOLOGY REVIEW

The number of plants in each treatment/disposal category is given in Table VI-1. As shown in this table, the most frequently employed treatment in the industry is biological oxidation, followed by activated carbon, incineration, chemical oxidation, hydrolysis, steam stripping, multimedia filtration, resin adsorption, and metals separation.

The volume of wastewater generated was evaluated on a plant-by-plant basis for the industry. This was performed in order to document the actual ranges of flows which were being treated and/or disposed by various technologies throughout the industry. The results of this analysis are shown for the pesticide active ingredient portion of plant wastewater flow in Figure VI-1. Based on this figure it was concluded that for flows less than 0.001 MGD, and for flows between 0.001 and 0.01 MGD, contract hauling and evaporation ponds, respectively, should be provided as alternatives. At flows greater than 0.01 MGD activated sludge and aerated lagoons become cost-effective. It should be noted that the actual flows treated at each individual plants are almost always larger than these shown here due to the inclusion of wastewaters from pesticide intermediates, other chemical products, cooling waters, and storm waters which are comingled and treated jointly along with the pesticide active ingredient wastewaters.

The following discussion provides descriptions of these currently operating systems, as well as systems which were considered in developing treatment recommendations for the industry. The discussion is in the general order of pretreatment, secondary treatment, and tertiary treatment systems.

Steam Stripping

Stripping operations involve passing a gas or vapor through a liquid with sufficient contact so that volatile components are transferred from liquid to the gas phase. The driving force for such an operation is the concentration differential between the liquid and concentrated

equilibrium point of the gas. The transferred compound may then be recovered by condensing the stripping vapor. More complete separation of components may be obtained through refluxing of the stripped condensate. In the pesticide industry both steam and vacuum stripping have been demonstrated to be applicable to groups of priority pollutants such as volatile aromatics, halomethanes, and chloroethanes, as well as a variety of nonpriority pollutant compounds such as xylene, hexane, methanol, ethylamine, and ammonia.

Full-Scale Systems--Table VI-2 presents the design data for eight stripping systems used in the pesticide industry. Table VI-3 provides operating data on these same systems. As shown in Plants 2, 4, 6, and 8, the principal volatile component stripped is normally removed at least 90 percent. Lower-level volatile impurities are often removed to a lesser degree.

Plant 1 operates separate steam strippers for wastewater from the A, B, C, and D pesticide processes. The B pesticide stripper is designed primarily for the removal of methylene chloride (dichloromethane). The stripper contains 15 feet of packing containing 1 inch polypropylene saddles, to which is fed 8,000 pounds per hour wastewater and 1,860 pounds per hour steam. Stripped compounds are recycled to the process with a net economic savings being realized. Table VI-3 presents three days of verification sampling which showed that 99.9 percent of the methylene chloride present was removed, down to less than 0.01 mg/l. Although this analysis was not conducted per protocol, the percent removal conformed to plant design.

The stripper used for C and D pesticide wastewater at Plant 1 is operated for the removal of a nonpriority pollutant, xylene. The A pesticide process utilizes a vacuum stripper for the recovery of a nonpriority pollutant, isobutyl alcohol. No data are available to document the removal efficiency for xylene or isobutyl alcohol in the abovementioned systems.

Plant 2 operates a steam stripper to treat the combined wastewaters of Pesticides E, F, G, and other nonpesticide products. As shown in Table VI-3, the stripper removes chloroform and hexane to less than 5 mg/l at a removal rate of greater than 92.9 percent. Forty-five gallons per minute of wastewater is preheated before entering the 24-tray stripper comprising six theoretical units. The stripped compounds are disposed by on-site incineration.

Plant 3 utilizes steam stripping treatment for wastewater from 10 of its pesticide processes. Methanol, toluene, and ethylene dichloride are stripped and recovered from wastewater when they are used in the process or as extraction solvents. No data are available to document the effectiveness of these individual pretreatment units since the plant would not participate in EPA verification sampling; however, no volatile organics have been detected over 1 mg/l in screening sampling of the combined raw waste load at this plant.

Plant 4 operates a steam stripper for the removal of ammonia and ethylamine from Pesticide R process wastewater. The process water enters the stripper at a flow of 0.072 MGD and approximately 100°C. From verification sampling the removal rate of ammonia through the stripper was determined to be greater than 90 percent, resulting in an effluent ammonia level of 5.00 mg/l as shown in Table VI-3.

Plant 5 uses steam stripping for the removal of 1,2-dichloroethane from Pesticide S and Pesticide S intermediate process wastewaters. 1,2-Dichloroethane, a solvent used in the Pesticide S process, is recovered and recycled to the process. No monitoring of solvent removal is currently available.

Plant 6 operates a packed bed steam stripper for the removal of ammonia from Pesticide T process wastewater. Pesticide T wastewater enters the stripper at a temperature of 80°C and pH of 12 to enhance ammonia removal. Steam is added at a rate of 1,400 pounds per hour to the 0.0326-MGD stream. EPA verification data presented in Table VI-3 show that the ammonia removal rate is 98.8 percent, resulting in an effluent of 98.0 mg/l. Split sample data analyses by the plant reported a 96.3 percent removal rate for ammonia. Stripper overheads, containing ammonia and organics are incinerated on-site.

Plant 7 uses steam stripping treatment for wastewater from the U pesticide process. Methylene chloride is recovered from the steam stripper and recycled to the process. Stripped spent beer wastewater is pretreated and discharged to a POTW. No data are available to document the effectiveness of the steam stripper treatment system for the removal of methylene chloride.

Plant 8 operates a vacuum stripper for treatment of wastewater from the V, W, and X pesticide processes. The stripper was installed to eliminate agglomeration of toluene in the treatment solvent regenerant for the subsequent resin system. The original design was to remove toluene, used as an extractant solvent, from approximately 600 mg/l to less than 10 mg/l, while at the same time reducing the temperature of the process stream so as to improve resin adsorption effectiveness. EPA verification sampling presented in Table VI-3 showed that the vacuum stripper removed greater than 70.7 percent of the toluene present to approximately 29.1 mg/l in the stripper effluent. More recent EPA region sampling data have indicated a removal of from 94.5 to 95.4 percent.

During 1980 an in-depth sampling and analytical program was conducted at three plants in the Organic Chemicals Industry which utilize steam stripping. Data from these studies are presented as follows, with emphasis on those pollutants to be regulated in the Pesticide Industry.

Plant A conducted more than 30 days of sampling on a steam stripper designed to remove nitrobenzene from wastewater. Data showed that benzene, a pollutant to be regulated in the Pesticide Industry, was also

removed by an average of 98.5 percent, from an influent of <15.4 mg/l to an effluent of <0.230 mg/l.

Plant B conducted more than 40 days of sampling on a steam stripper designed to remove vinyl chloride from wastewater. Operating data for pollutants to be regulated in the Pesticide Industry were: 99.5 percent removal of methylene chloride, from <3.02 mg/l to <0.0141 mg/l; and >70.3 percent removal of toluene, from 178 mg/l to <52.8 mg/l.

Plant C conducted approximately 1 week of sampling at each of two strippers designed to remove chloroethane. Operating data for pollutants to be regulated in the Pesticide Industry were:

	Stripper 1		
Compound	Influent (mg/l)	Effluent (mg/l)	Percent Removal
Dichloromethane	1,430	<0.0153	>99.99
Carbon tetrachloride	<665	<0.0549	>99.99
Chloroform	<8.81	1.15	<86.9

	Stripper 2		
Compound	Influent (mg/l)	Effluent (mg/l)	Percent Removal
Dichloromethane	4.73	<0.0021	>99.95
Chloroform	<18.6	<1.9	89.8
1,2-Dichloroethane	<36.2	4.36	<88.0
Carbon tetrachloride	<9.7	<0.030	99.7
Benzene	24.1	<0.042	>99.8
Toluene	22.3	<0.091	>99.6

Additional sampling of steam stripping treatment in the Organic Chemicals Industry was conducted at Plant D's facility on December 14, 1979. Results for pollutants to be regulated in the Pesticide Industry were as follows:

Compound	Influent (mg/l)	Effluent (mg/l)	Percent Removal
Methylene chloride	34	<0.01	>99.97
Chloroform	4,509	<0.01	>99.99
1,2-Dichloroethane	9,030	<0.01	>99.99

Treatability Studies--Coco, et al. (1978) evaluated the treatment of process effluents containing chlorinated hydrocarbons and aromatic hydrocarbons using steam stripping. This unit operation removed up to 99 percent of the chlorinated hydrocarbons (ethylene dichloride, which was the major organic component in the process effluent was consistently reduced from more than 1,000 mg/l in the stripper feed to less than 1 mg/l in the stripper bottoms) and up to 75 percent of the total organic carbon (TOC). Steam stripping, as discussed by the authors,

offers possibilities for application to the halogenated hydrocarbon process effluent and the aromatic rich effluent from styrene plants. On the other hand, aromatic amines and polyols wastewater would not permit successful steam stripping, due to the number of various organics present.

Hwang and Fahrenthold (1980) performed treatability evaluations to determine the extent to which organic priority pollutants can be steam stripped. Both mixture thermodynamics and tray efficiencies were considered in this evaluation. The results indicated that due to volatility and high activity coefficients of organic priority pollutants, steam stripping is an effective means of removing these pollutants from wastewater. Based on a raw waste load at solubility, and a column operating with aqueous reflux, the following effluent concentrations, tray requirements, and column efficiencies were predicted for priority pollutants to be regulated in the pesticide industry.

Compound	Effluent Concentration (ppb)	Number of Actual Trays Required	Column Efficiency (Percent)
Carbon tetrachloride	50	4	100
Chloroform	50	6	100
Methyl chloride	50	6	100
Methylene chloride	50	6	100
Bis(2-chloroethyl) ether	140	20	53
Benzene	50	5	100
Chlorobenzene	50	5	100
Toluene	50	5	98
1,3-Dichloropropene	50	5	100
1,2-Dichloroethane	50	6	100
Tetrachloroethylene	50	4	99
Methyl bromide	50	3	100
1,2-Dichlorobenzene	50	4	96
1,4-Dichlorobenzene	50	4	100
1,2,4-Trichlorobenzene	50	4	99

ESE (1975) conducted bench and pilot scale steam stripping studies at an ethyl benzene/styrene monomer chemicals plant. Benzene was removed from 102 mg/l to 0.6 mg/l at optimum conditions; a full-scale system was designed to remove 99.4 percent of the aromatic hydrocarbons with a 2-foot diameter, 18-foot-high column with 9 feet of packing for a flow of 30,000 gallons per day.

Chemical Oxidation

Oxidizing agents have been shown to be extremely effective for the removal of many complex organics from wastewater, including phenols, cyanide, selected pesticides such as ureas and uracils, COD, and organometallic complexes. The most widely used oxidants in the pesticide industry are chlorine and hydrogen peroxide.

Oxidation reactions and kinetics can be selectively controlled by altering the pH of the wastewater. For example, under alkaline conditions the hypochlorite ion destroys compounds such as glycols, chloroalcohols, organic acids, and ketones (Mulligan, 1976), as well as cyanide and organo-metallic pesticides. In using chlorine the potential for creating chloromethanes, chloroamines, or chlorophenols should be considered.

Hydrogen peroxide oxidizes phenol readily when the reaction is catalyzed by ferrous sulfate; however, it has generally been not economically practical to complete the oxidation to carbon dioxide and water (Strunk, 1979). Hydrogen peroxide can also be used to reduce odor, which may be present due to the use of sulfur compounds.

Hydrogen peroxide oxidation removes both cyanide and metals in cyanide-containing waters (U.S. EPA, 1980c). The cyanide is converted to cyanate and the metals are precipitated as oxides or hydroxides. The metals are then removed from solution by either settling or filtration. This process can reduce total cyanide to less than 0.1 mg/l and metals such as zinc and cadmium to less than 1 mg/l.

Ozone has been shown (Gould, 1976) to give virtually complete removal of phenol and 70 to 80 percent removal of COD; however, it becomes costly as 100 percent organic removal is approached. Because ozone is unstable and must be generated on-site, safety factors must be considered.

Full-Scale Systems--Tables VI-4 and VI-5 present design and operating data for nine pesticide manufacturers utilizing chemical oxidation. In these systems over 98 percent of cyanide, phenol, and pesticides are removed while COD and other organics also are greatly reduced.

Plant 1 uses batch chemical oxidation treatment of wastewater from five of its pesticide processes. Hydrogen peroxide is used for the reduction of phenolic compounds in the wastewaters from Pesticides A, C, D, and E. Sodium hypochlorite is used primarily for odor control in the B pesticide process. Although the plant declined to allow EPA contractor sampling to document the effectiveness of these individual pretreatment units, two data points for phenol were observed during screening and verification sampling to be less than 1 mg/l in the combined raw waste load prior to secondary treatment and direct discharge of wastewater at this plant.

Plant 2 adds formaldehyde to cyanide-containing wastewaters to form cyanohydrin, which hydrolyzes to ammonia and glycolic acid, in their F pesticide process discharge. This system is designed to add 1.0 gpm formaldehyde to a 110 gpm waste stream to reduce cyanide from 200 mg/l to less than 1 mg/l after a detention time of four days. Table VI-5 shows that during three days of verification sampling, cyanide was reduced to 99.6 percent from 5,503 mg/l to 19.7 mg/l, although these analyses were not conducted per protocol. It should be noted that plant

monitoring after chemical oxidation, hydrolysis, steam stripping, and biological oxidation and before direct discharge show cyanide reduced to less than 0.0125 mg/l. During verification sampling it was also determined that chemical oxidation removed 99.8 percent of Pesticide F, from 83.2 mg/l to <0.145 mg/l.

Plant 3 has in the past used chlorine chemical oxidation for the purpose of reducing fish toxicity in wastewaters from its G and H pesticide processes. During three days of verification sampling at this treatment unit, only Pesticide H was in production. Table VI-5 shows the results of split samples from this period as analyzed by the verification contractor and as supplied by the plant. The principal pollutant removed in the chemical oxidation unit was the Pesticide H, which was reduced by more than 99.9 percent from 398 mg/l to 0.187 mg/l. Plant data have indicated a long-term removal of 83.4 percent Pesticide H.

Significant removal of Pesticides S (63.6 to 99.3 percent), T (99.5 percent), G (90.5 percent), and U (54.4 percent) was observed. When chlorine is added to wastewater containing compounds such as methylene chloride, chemical substitution of hydrogen by halogens may create or increase the concentration of compounds such as chloroform. For example, split verification samples showed chloroform increasing from less than 0.1 mg/l to approximately 1 mg/l. The wastewater from chlorine oxidation at Plant 3 receives subsequent biological treatment before direct discharge.

Plant 4 has recently designed and constructed a hydrogen peroxide oxidation system. Operating data are not yet available. Pretreatment of pesticide and pesticide intermediate wastewater by chemical oxidation was deemed necessary to make this stream suitable for subsequent biological treatment. Treatability studies were conducted which predicted removals of pesticide (48.8 percent), COD (50 percent), and TOC (41 percent), based on addition of 1 percent by volume of hydrogen peroxide after acidification to pH 1 to encourage precipitation. Sodium hypochlorite was determined to be an equally effective and more economical oxidant; however, it was abandoned due to its possible potential for creating residual quantities of chlorinated hydrocarbons. The wastewater from chemical oxidation at Plant 4 receives subsequent biological treatment before direct discharge.

Plant 5 uses hydrogen peroxide to oxidize both phenol and COD in its pesticide wastewaters. As shown in Table VI-5, the phenol is reduced by 99.8 percent from 1,100 mg/l to 2.03 mg/l. This removal was achieved by using a 1:1 ratio of 100 percent hydrogen peroxide to phenol in the plant's aerated lagoon. At the same time, pesticides in the wastewater are reduced to 0.023 mg/l. A 3:1 ratio of 100 percent hydrogen peroxide to phenol has recently been used to improve COD removal. The plant subsequently disposes of wastewater via direct discharge.

Plant 6 operates a chlorine oxidation treatment unit to remove toxic compounds from wastewater generated in the L and M pesticide processes. The wastewater is held approximately one hour at pH 10-12 and

temperature of 107°C. Chlorine is added at a rate of 3.25 gallons per 1,000 gallons of wastewater treated. Pesticides are not detected in the discharge from chlorine treatment. The wastewater from chlorine oxidation is subsequently evaporated to achieve no discharge.

Plant 7 uses sodium hypochlorite to remove odor and COD generated by diethylamine raw material in wastewater from its N pesticide process. Wastewater is held for 0.5 to 8.0 hours at pH 7-12 while 1.5 gallons of sodium hypochlorite bleach (12 to 15 percent available chlorine) is added to each 1,000 gallons. The wastewater from chlorine oxidation is subsequently discharged to a POTW.

Plant 8 is reported to use chemical oxidation for wastewaters from its O, P, and Q pesticide processes. According to the Plant 308 response, no data on this system are currently available. The plant subsequently discharges wastewater to a POTW.

Plant 9 uses chemical oxidation to treat wastewaters from its R pesticide process. Cobaltous chloride is used as a catalyst in the presence of diffused air to oxidize sulfites and other potentially toxic compounds. No analyses of priority pollutants are conducted by the plant. Wastewater from chemical oxidation is disposed by direct discharge.

Barnes (1978) reports that oxidation by chlorine is a common treatment employed by 90 companies in the electroplating industry for the removal of cyanide. By analyzing data from 58 plants with oxidation treatment, it was concluded that 36 percent achieve total cyanide values less than or equal to 0.04 mg/l and 50 percent less than 0.11 mg/l.

Cyanide may be precipitated and settled out of wastewaters by the addition of zinc sulfate or ferrous sulfate. Data from coil coating plants (U.S. EPA, 1980c) using cyanide precipitation show a cyanide mean effluent concentration of 0.07 mg/l.

Treatability Studies--Plant 10 conducted a treatability study on a waste containing phosphorous-sulfur compounds and high chlorides. Several chemical oxidants were considered in this study including dichromate, hydrogen peroxide, and permanganate. Treatment with peroxide was the most effective showing COD removals in the 65 to 75 percent range on the raw waste and 45 to 50 percent on the effluent from a nine-stage biological pilot plant.

In the manufacture of cyanuric chloride for triazine pesticides, hydrocyanic acid and cyanic acid may be present. Lowenback (1978) reports that these cyanides may be oxidized to carbon dioxide and nitrogen gas in the presence of excess base and chlorine.

Sweeny (1979) reported complete or nearly complete degradation of selected organic compounds including cyclodienes, atrazine, and DDT-type pesticides by methods such as chemical reduction and use of columns (diluted and fluidized beds). The reductive degradation process

primarily involved dechlorination, using catalyzed iron as the most effective reducing agent. The use of a column was the most efficient method. Sweeny reported a 99.8 percent p-nitrophenol reduction at a flow rate of 22.8 gpm/sq. ft. in a fluidized bed.

Rice (1980b) and Novak (1980), summarizing the results of separate surveys of published literature dealing with the use of ozone for treating industrial water and wastewater, reported that ozone is mainly used for cyanide removal, disinfection, dissolved organics oxidation, and color removal.

Rice (1980b) reported that ozonation of parathion, malathion, and heptachlor produces paraoxon, malaoxon, and heptachlor epoxide, respectively. Continued ozonation of these oxons destroys them and their toxicities, but heptachlor epoxide is stable to further oxidation by ozone.

Rice (1980a) reported on European pilot studies and studies in European drinking-water treatment plants showing that pre-ozonation followed by activated carbon adsorption results in:

1. Increased capacity of the carbon to remove organics (by a factor of about 10), and

2. Increased operating life of the carbon columns (up to 3 years).

Metals Separation

Metallic ions in soluble form are commonly removed from wastewater by conversion to an insoluble form followed by a separation process. Metallic hydroxides are formed at optimum pH (approximately pH = 9.0 for copper and zinc found in the pesticide industry) through alteration of the ionic equilibrium by an agent such as lime, soda ash, or caustic. Clarification or filtration is normally employed to remove the precipitate from solution. Concentrations of 0.5 mg/l are achievable using these or similar methods. Alternative processes which may be considered are ion exchange, oxidation or reduction, reverse osmosis, or activated carbon.

Full-Scale Systems--Three priority pollutant metals separation systems are operating in the pesticide industry as shown in Table VI-6. Plant 1 operates a hydrogen sulfide precipitation system in order to remove copper from its A pesticide wastewater. Other separation methods attempted were precipitation of copper using ammonium thiocyanate, and extraction with liquid ionic exchange resins. The operating system consists of an agitated precipitator to which the hydrogen sulfide is added, a soak vessel to which sulfur dioxide is added, a neutralization step using ammonia, followed by gravity separation and centrifuging. Copper is removed from 4,500 to 2.2 mg/l or from 5,350 to 2.8 mg/l.

Plant 2 utilizes sodium sulfide for the precipitation of copper from the B pesticide wastewater. Although removals of copper through precipitation is unknown, verification sampling data by EPA contractors showed copper concentration in all plant process waters to the primary secondary treatment to be 23 ug/l.

Plant 3 has installed a chemical precipitation step for the removal of arsenic and zinc from surface water runoff. Ferric sulfate and lime are alternately added, while the wastewater is vacuum filtered and sludge is contract hauled. The entire treatment system consists of dual media filtration, carbon adsorption, ion exchange, chemical precipitation, and vacuum filtration. Verification sampling across the entire system by EPA contractors showed arsenic removal from 6.9 to 0.2 mg/l (97.1 percent) and zinc removal from 0.34 to 0.11 mg/l (67.6 percent).

Barnes (1978) reports that high pH adjustment followed by clarification is a common full-scale treatment employed in the electroplating industry. Data from 25 plants utilizing this treatment show that the average effluent concentrations for copper and zinc are 0.49 mg/l and 0.72 mg/l, respectively.

As reported in the Development Document for the Coil Coating industry (U.S. EPA, 1980c), data from 55 full-scale metal separation systems in the metal industry employing pH adjustment and hydroxide precipitation using lime or caustic followed by settling (tank, lagoon, or clarifier) for solids removal show mean effluent concentrations and percent removal for metals as follows:

Metal	No. Data Points	Mean Raw Waste Concentration (mg/l)	Mean Effluent Concentration (mg/l)	Percent Removal
Copper	74	23.2	0.61	97.4
Zinc	69	27.7	0.40	98.6

The Development Document for the Coil Coating Industry (U.S. EPA, 1980c) also reports long-term data from two plants in the industry using precipitation-settling systems followed by filtration. Both plants neutralize wastewater and precipitate metals with lime. A clarifier is used as settling media. For removal of suspended solids, Plant 4 uses pressure filtration and Plant 5 uses a rapid sand filter. The data from these systems are as follows:

	Plant 4		Plant 5	
Metal	Raw Waste Range (mg/l)	Mean Effluent (mg/l)	Raw Waste Range (mg/l)	Mean Effluent (mg/l)
Zinc	33.2-32.0	0.2	2.35-3.39	0.035
Copper	0.08-0.45	0.0175	0.09-0.27	0.011

Treatability Studies--Amron Corporation (1979) reported on a system designed to remove high concentrations of toxic heavy metals in their wastewater. The method is an hydroxide/modified sulfide precipitation

system that uses an insoluble sulfide salt which must have a solubility greater than the heavy metal sulfide to be precipitated. It was found that ferrous sulfide meets these requirements. Heavy metal removals reported represent mean values obtained over a 6-month period of operations.

Metal	Influent (mg/l)	Effluent (mg/l)	Removal (Percent)
Phosphorus	247	0.40	99.8
Zinc	27	<0.10	99.6+
Iron	85	0.04	99.9
Chromium	2	<0.10	95+
Nickel	0.61	0.10	83.6

Lanouette and Paulson (1976) have made a literature review of the various methods employed to treat wastewaters containing heavy metals. Typical estimates of the achievable concentration of heavy metals using precipitation were:

Heavy Metal	Achievable Concentration (mg/l)	Precipitating Agent
Copper	0.5	Caustic, lime
Zinc	0.5	Caustic, lime
Cadmium	0.3	Soda ash
Nickel	0.5	Soda ash
Chromium (total)	0.5	Caustic, lime

Gupta, et al. (1978) reported on a bench test where arsenic was effectively treated from various waters. Experiments were carried out on fresh water, sea water, a 10:1 mixture of fresh water and sea water, and a sodium chloride solution. The best removal rate occurred with arsenic in the +5 oxidation state and with a pH of 4 to 7 using columns of activated media. The materials used were activated bauxite, activated alumina, and activated carbon. A summary of the results are listed below.

Percent Arsenic Removal

	Activated Bauxite	Activated Alumina	Activated Carbon
Fresh Water	97-100	99-100	83.5-96.5
Saltwater 1:10	93-97.3	98-99	74.3-95
Sea Water	92.5-97.5	97-99	71.1-92.8
NaCl	87-94	95.8-97	62.6-89.7

Pilot plant tests performed by Muruyama, et al. (1975) evaluated the effect of precipitation with lime or coagulation with iron followed by activated carbon to remove heavy metals from wastewater. Data results are presented in the Activated Carbon Treatability Studies section.

Granular Activated Carbon

Activated carbon adsorption is a physical separation process in which highly porous carbon particles remove a variety of substances from water. Adsorption is affected by many factors including molecular size of the adsorbate, solubility of the adsorbate and pore structure of the carbon. The characteristics of activated carbon treatment that apply to the pesticide industry may be summarized below:

1. Increasing molecular weight is conducive to better adsorption.

2. The degree of adsorption increases as adsorbate solubility decreases.

3. Aromatic compounds tend to be more readily adsorbed than aliphatics.

4. Adsorption is pH dependent.

Full-Scale Systems--Table VI-7 provides design criteria for 17 plants using activated carbon in the treatment of pesticide wastewaters. Table VI-8 presents operating data on these same systems.

Pesticides, phenols, and nitrosamines are all shown to be effectively removed by activated carbon. Volatile organics and oxygen demanding substances can be significantly removed although the degree of removal is plant specific. The majority of these systems are long contact time and high carbon usage rate systems which are applied as a pretreatment for the removal of organics from concentrated streams. Three plants operate tertiary carbon systems which use shorter contact times and have lower carbon usage rates.

Plant 1 operates an activated carbon treatment system for wastewaters from nine pesticide processes. Activated carbon is used as pretreatment to remove phenols, Pesticides A, B, and other structurally similar pesticides prior to discharge to a POTW.

Wastewater at Plant 1 first enters a 3,000 gallon surge tank, then is transferred to a 160,000 gallon equalization tank to permit handling a number of separate variable flows on different production schedules from the nine process areas. The equalization tank also permits a constant flow rate for maximizing carbon adsorption efficiency. The adsorbers are sized for 120-gallon per minute flow with normal flow of approximately 50 gallons per minute. The wastewater at pH 1.0 to 1.5 is pumped through two 8,000 gallon Douglas Fir wooden tanks operating in an upflow series mode each containing 18,000 pounds of carbon each. The low pH of the influent stream facilitates adsorption of these phenolic compounds. An empty bed contact time of 320 minutes is provided. The carbon treated effluent is adjusted to pH 5.5 to 9.0 using a lime slurry prior to discharge. Area drainage is treated for phenols as needed by two additional carbon columns of the same size.

As shown in Table VI-8, verification sampling at Plant 1 indicated that total phenol in the effluent from the activated carbon columns averaged less than 0.143 mg/l and 0.329 from two separate monitoring periods. This represents a 99.8 percent removal of total phenol. Plant operating data over the past two years have shown an effluent phenol level of less than 1.0 mg/l. The columns also remove 99.9 percent of Pesticides A and B. Due to the presence of glycolic acid and butryolactone, BOD, and COD pass through the column with relatively little removal.

Plant 1 contracts for off-site thermal reactivation of carbon. Normally, carbon usage is 26 pounds per 1,000 gallons wastewater treated.

Plant 2 uses a two-column series activated carbon treatment system for J and K pesticide wastewater. The downflow carbon system is designed to operate at 30 gallons per minute, 24 hours per day, during a production run. This pesticide production schedule is normally 5 days a week, 24 hours a day. Process wastewater, process area drainage, and spent acid from the manufacturing process are treated in the carbon unit. Each column is charged with 20,000 pounds of carbon. Because both pesticides are batch production units, wastewater and spent acid are fed into holding tanks with several days retention time. The wastewater is treated in the carbon system at a pH of 0.5 to 4.0 with an empty bed contact time of 588 minutes. Carbon column effluent is combined in a holding tank with other nonpesticide wastewater for a plantwide pH adjustment prior to direct discharge.

Verification sampling at Plant 2 showed that the concentration of the manufactured Pesticide K was reduced from a level of 0.465 mg/l to less than 0.001 mg/l constituting a 99.8+ percent removal by the carbon adsorption unit. Previous Pesticide K sampling at this plant during 1977 had shown removal of 99.9 percent to 0.0182 mg/l. Total phenol was reduced to a concentration of less than 0.001 mg/l with a removal of 82.1 percent. The reduction in the concentration of volatile organics was not consistent. The removal of conventional pollutants ranged from 36.2 percent for TSS to 90.7 for TOC.

The carbon usage rate at Plant 2 for this unit is 81.5 pounds per 1,000 gallons. Normal plant procedure directs that a carbon bed is replaced in one column every 30 days. Prior to off-site thermal reactivation carbon is hydraulically pumped from the column into a caustic soda neutralization tank due to its strongly acidic nature.

Plant 3 operates an activated carbon treatment system for aqueous wastes from the L, M, N, and O pesticide processes. The carbon unit treats 1.2 to 1.4 MGD wastewater and operates 24 hours a day. The system consists of five carbon towers operated in parallel. Normally three towers are in operation. The flow rate into each carbon bed is 3.6 gallons per minute per square foot. An average detention time for each tower is 19.1 minutes. Prior to carbon treatment and direct discharge the wastewater is pH adjusted to 7.0 for maximum carbon

adsorption of pesticides and organics present in this stream. Following carbon the wastewater is directly discharged.

The carbon system at Plant 3 removed between 92.3 and 96.9 percent of L, M, and O manufactured pesticides during EPA verification sampling, as shown in Table VI-8. In each case the carbon effluent contained less than 1 mg/l pesticide. Plant 3 reported >85.7 and >91.2 percent removal for Pesticides L and M, respectively, during the period from January 1979 to April 1980. An average carbon effluent concentration of 0.0055 mg/l for Pesticide O was reported for 154 monitoring days.

Halomethanes at Plant 3 were adsorbed with typical removals of 66.3 percent for chloroform and 77.9 percent for carbon tetrachloride. During EPA verification sampling, minimal reductions of low level phenols by carbon treatment were observed. As shown in Table VI-8 there was an increase in BOD across the system. In this case it is likely that organics measured as BOD were desorbed because of displacement by more adsorbable influent compounds.

Approximately 20,000 pounds of carbon are exchanged per column every 13 days. The carbon usage rate is calculated as 3.9 pounds per 1,000 gallons of treated wastewater. Plant 3 uses off-site thermal reactivation of carbon.

Plant 4 uses two dedicated activated carbon treatment systems for wastewaters from the P and Q pesticide processes. Rainwater runoff and spent caustic from air pollution control scrubbers from the P pesticide process passes through activated carbon beds at a rate of 15,000 gallons per day. Effluent from the beds is combined with cooling tower blowdown before treatment in the main biological plant. The carbon system was installed mainly to reduce levels of the pesticide and phenols. Plant data showed that Pesticide P enters the carbon system at a concentration of 9,300 mg/l and is reduced to 1.7 mg/l constituting a 99.9 percent removal. The compound 2,4-dichlorophenol is reduced 99.9 percent from 42,000 to 0.82 mg/l. Other phenols and volatile organics are also significantly reduced.

The carbon bed dedicated to the Q pesticide process at Plant 4 was installed to treat combined wastewater from the N-isopropyl aniline distillation, the neutralized HCL cleanup effluent, cooling tower blowdown, storm water runoff, and washdown water. Approximately 12,000 gallons per day is treated by this unit prior to combining with other plant effluents in the biological treatment system. The activated carbon bed was designed to remove the pesticide and volatile organics in the wastewater. As shown in Table VI-8, plant data indicated that Pesticide Q was reduced from 15 to 0.01 mg/l. The percent removal is therefore 99.9 percent. Benzene and toluene were reduced by greater than 86.3 percent and 66.7 percent, respectively. Halomethanes and phenols were also reduced at significant levels which ranged from 88.9 to greater than 98.9 percent. The Pesticide Q spent carbon is incinerated without regeneration. No additional information is available for either carbon system.

Plant 5 installed an activated carbon treatment system in 1979 to treat wastewater from the pesticide process. The major source of wastewater fed to the unit is the aqueous discharge from vacuum filtration of the mother liquor. Approximately 1.30 million gallons per day of wastewater enters the adsorbers at a pH of 6 to 12. The carbon system consists of three 2-stage adsorption trains operated in parallel. The empty bed contact time of each train is 18 to 52 minutes.

System start-up data at Plant 5 showed a pesticide influent concentration of 45.7 mg/l and an estimated effluent concentration of 12.4 mg/l, constituting a 72.9 percent removal. Subsequent analyses during 1978 and 1980 revealed that the carbon system was achieving a 96.5 percent pesticide removal with an effluent pesticide concentration of 4.7 mg/l. The carbon usage rate is 20 to 33.5 pounds per 1,000 gallons wastewater treated with a loading of 9 to 15 pounds TOC per 100 pounds carbon. Spent carbon is reactivated on-site by an infrared electric furnace.

Toluene was reported by Plant 5 at <0.1 mg/l, a >98.3 percent removal, following carbon adsorption. The reduction of conventional parameters was inconsistent, with a removal range of zero to 93.7 percent.

Plant 6 operates an activated carbon system as pretreatment for removal of nitrosamines and Pesticide U from certain process wastes. Amination wastes from the U active-ingredient pesticide process are treated in three carbon columns operating in series. Wastewater enters the system at a pH of 8.5 to 9.5. Between 50,000 to 75,000 gallons per day of wastewater is treated by these adsorbers, and empty bed contact time is usually 1,000 minutes. Carbon in the lead column is replaced about once a week, resulting in a carbon usage of 136 pounds per 1,000 gallons treated. When produced, V and W pesticide wastewaters are also treated in the same carbon treatment system.

Approximately 0.025 to 0.030 MGD of nitration wastes from the U pesticide intermediate process at Plant 6 are treated by carbon adsorption in three columns operating in series, with a fourth column is used for storage. Each column has a bed volume of 2,500 gallons wastewater. The pH of the intermediate waste is 1.5. Approximately 571 minutes of contact time is usually required. The arrangement of the columns in the treatment scheme is changed once per day, with the former lead column being placed in storage. Effluent from both series of carbon columns is fed to aerobic biological treatment lagoons, clarified, and passed to tertiary treatment prior to final discharge. Spent carbon is thermally reactivated off-site.

In the amination process carbon system at Plant 6, U pesticide wastes were removed during verification sampling, from 14.6 mg/l to 0.0713 mg/l, or 99.5 percent. Plant data also showed a long-term average removal of from 98.5 to 99.8 percent. The compound N-nitrosodi-n-propylamine was reduced during verification to a level of 0.0041 mg/l, a 99.8 percent removal. Plant data have indicated a long-term removal of from 77.6 to 90.3 percent as shown in Table VI-8. Incidental removal of methylene chloride was also noted. Other parameters not mentioned

above did not show a significant decrease in concentration. The nitration carbon system effectively reduced nitrosamine levels from 82 to greater than 95 percent.

Wastewaters from Plant 7 X and Y batch pesticide processes are treated by an activated carbon system. Pesticide and miscellaneous chemical process wastewater is combined with area drainage and washdown water and sent to carbon treatment. All wastewater first enters an equalization/ neutralization pond where the pH is adjusted to between 6 and 8. Neutralized wastewater is pumped to a holding pond and then to the carbon system at the rate of 30,000 gallons per day. The system consists of two carbon columns operating in series. Carbon usage is reported at 20,000 pounds per week (95 pounds per 1,000 gallons treated) at a loading of 0.25 pounds TOC per pound carbon. Based on an approximate bed volume of 5,000 gallons per adsorber, a total system empty bed contact time of 8 hours is realized. Carbon effluent flows to a holding pond and is pumped to a spray aeration pond prior to final discharge.

As shown in Table VI-8, manufactured pesticides at Plant 7 are removed by 99.4 percent and greater. Traditional parameters are reduced by 32.1 to 90.7 percent. Toluene was reduced to a concentration of less than 0.007 mg/l resulting in over 94.9 percent removal. Other organics were reduced to nondetectable levels. Plant 7 uses off-site, thermal reactivation of spent carbon.

As the result of a recent treatability study, Plant 7 plans to construct a biological oxidation system to remove the bulk of the organics from the wastewater. The carbon system would be retained for lower strength wastewaters which have been segregated.

Plant 8 operates two activated carbon columns for process wastewater from the water-based manufacture of Pesticide Z. The columns operate in series, each having a capacity of 20,000 pounds of carbon. At 0.16 MGD, the contact time is approximately 100 minutes. The average usage of carbon is 2.89 pounds per 1,000 gallons treated. Wastewater from the process is first pumped to a holding tank and fed through two multimedia filters to prevent suspended solids from plugging the adsorbers carbon system at a pH of 8 to 12. Effluent from the carbon columns is pH adjusted and clarified before discharge to a municipal treatment facility. The plant uses regenerated carbon supplied by an off-site contractor.

Both verification and plant reports at Plant 8 show a removal of 63.6 to 68 percent for Pesticide Z. This removal is determined by an effluent objective of 10 mg/l for Pesticide Z which has been arbitrarily set by the plant. Greater removal can technically be achieved, if desired, by more frequent carbon replacement. Total suspended solids were reduced from 77.5 mg/l to 32.3 mg/l, constituting a 58.3 percent removal.

Plant 9 operates an activated carbon treatment unit for basic (high pH) wastewater from the AA pesticide process. This unit was designed to reduce concentrations of pesticide, monochlorobenzene, and

1,2-dichloroethane which are raw materials used in the reaction process. Wastewater is treated by peroxide oxidation prior to carbon adsorption. Approximately 70,000 gallons per day is passed through this unit before treatment in the central biological treatment system. No data currently exist to document the efficiency of this activated carbon unit since the plant is still in a start-up phase.

Plant 10 uses granular activated carbon as treatment for wastewaters from reactor exterior and floor washings in the manufacturing area of the BB pesticide process. Wastewater is stored in 6,000-gallon tanks prior to the two activated carbon columns. Influent wastewater enters at a pH of 5 to 9. Due to the low volume of wastewater, the flow through the columns is intermittent, operating some two to three hours per day. Each column has a capacity of 20,000 pounds of carbon and operates downflow in series. Approximate detention time is 250 minutes with a carbon usage rate of 69.3 pounds of carbon used per 1,000 gallons wastewater treated. Following carbon treatment, wastewater is held in a storage tank for complete reuse as washwater in order to achieve a no discharge status. Spent carbon is contracted for off-site reactivation.

Both plant and verification monitoring at Plant 10 show that Pesticide BB can be removed from wastewaters by granular activated carbon by greater than 99 percent. In this same treatment system traditional parameters and halomethanes were also effectively reduced.

Plant 11 operates a granular activated carbon column to treat 0.001 MGD wash waters from the CC pesticide process and 500 gallons per day of discharge from the DD pesticide process dryer. This waste is combined with other process waste, noncontact and sanitary waste, and passes through an equalization basin, aerobic digestor, and clarifier prior to carbon adsorption. The plant has stated that no operating data are currently available for this treatment system.

Plant 12 uses a tertiary activated carbon unit to treat process waste, once-through cooling water, and surface water runoff from the EE pesticide manufacturing process. Approximately 2,800 gallons per day of wastewater is combined with other nonpesticide waste and passed through primary and secondary treatment as well as a sand filtration system prior to carbon treatment. The carbon system consists of two columns operating in series. Treated effluent is chlorinated before final discharge. No monitoring of Pesticide EE or organics has taken place. Spent carbon is reactivated on-site by a regeneration furnace. Furnace product is combined with fresh carbon makeup, then recycled to the system.

Plant 13 uses tertiary activated carbon columns for wastewater from the FF pesticide process. Wastewater treated by hydrolysis (0.01 MGD) from the FF pesticide process is combined with 0.028 MGD of Pesticide FF intermediate waste and 2.0 MGD of nonpesticide process waste. Preceding carbon treatment all wastewater passes through equalization, skimming, gravity separation, neutralization, and multimedia filtration. Influent wastewater to the columns has a pH of 6. The three activated carbon

columns operate upflow in parallel. Empty bed contact time is approximately 109 minutes. The amount of carbon in each column is 154,000 pounds. Carbon usage rate is 0.92 pounds of carbon per 1,000 gallons wastewater treated. Plant 13 uses an on-site regeneration of spent carbon.

Final plant effluent at Plant 13, which contains 4.0 MGD noncontact cooling water, showed Pesticide FF at a concentration of 0.00602 mg/l. Pesticide removal through the carbon columns has not been measured. TOC removal averages 29 percent for this high-flow, low carbon usage system.

At Plant 14, Pesticide GG was produced until January 1978. Although the wastewater was discharged to a public treatment system, Pesticide GG was pretreated in an activated carbon system prior to discharge. The raw waste was collected in a 1,000 gallon surge tank, passed through columns (2 feet in diameter by 10 feet high) at a pH of less than 1 with an empty bed contact time of 35 minutes, and stored until analysis had been completed. If the total of all pesticide chemicals was less than 5 mg/l, the wastewater was discharged to the municipal treatment system. If not, it was recycled through the downflow columns again. The carbon was regenerated with isopropanol and the solvent was incinerated. Carbon was replaced infrequently, approximately twice per year. This system was inefficient because of the small detention time and the necessity for frequent fresh carbon addition. Low flows allowed frequent recycling in order that their effluent objective be met. Table VI-8 presents 5-1/2 months of pesticide data by the plant, 6 days BOD, COD, TOC, TSS, and pesticide chemicals data by the plant, and 17 days of sampling analyzed by the EPA contractor.

Plant 15 installed two activated carbon columns operating in series to treat wastewater from the HH pesticide process. The pH of the waste is lowered to approximately pH 2 prior to carbon treatment. The plant reports an empty bed contact time of 7 hours. Approximately 27,700 gallons per day of Pesticide HH waste is treated. Carbon usage is reported to be 451 pounds per 1,000 gallons treated. Due to the relatively high carbon usage rate, Plant 15 is investigating additional pretreatment methods. Carbon effluent currently passes through steam stripping for ammonia removal and is combined with other process wastes prior to entering the central biological treatment system for subsequent direct discharge.

Verification sampling at Plant 15 showed approximately 77 percent of the TOC is removed in the carbon columns. Split sample results reported by the plant indicated an 83.1 percent removal. Analysis of the pesticide parameter by verification sampling showed a 99.8 percent removal. However, plant monitoring and verification split sampling data provided by the plant showed removals of 66.7 and 68.4 percent, respectively. Plant 15 participated in a self-sampling monitoring program which determined a long-term removal efficiency of from 98.6 to 99.9 percent. The influent suspended solids were found in concentrations from 3,000 to 4,094 mg/l. Traditional parameter removals are inconsistent.

Plant 16 uses activated carbon to treat wastewater from the ammonia recovery and neutralization steps of the II pesticide process. Wastewater at pH 11.6 to 12.5 enters two carbon beds operating downflow in series. The vessel size is 11 feet high by 10 feet in diameter. Approximately 20,000 pounds of carbon is contained in each bed. The empty bed contact time for the system is 91.5 minutes when operated at 120,000 gallons per day flow and 60.8 minutes when operated at 180,000 gallons per day. Each adsorber is replaced approximately every 2.3 days making carbon usage 71.6 pounds per 1,000 gallons treated for a flow of 0.120 MGD and 47.7 pounds per 1,000 gallons at 0.180 MGD. Plant 16 uses off-site reactivation of carbon. Activated carbon effluent flows through an aerated lagoon treatment system prior to discharge to a navigable waterway.

As shown in Table VI-8, Pesticide II was found at a concentration of less than 1,418 mg/l in the carbon influent at Plant 16. Pesticide II was reduced by 77.9 percent to less than 314 mg/l following adsorption. TOC was reduced by 68.4 percent from a concentration of 523 to 165 mg/l.

Plant 17 operates an activated carbon treatment system for stormwater runoff and washdown water from the JJ and KK pesticide process areas. The small flow of 400 to 500 gallons per day of JJ and KK pesticide wastewater is treated for 30 minutes in each of the two carbon beds. The carbon beds are 8 feet in diameter by 20 feet in height and operate in a downflow mode. The carbon usage rate is 2 pounds per 1,000 gallons treated. An off-site method of spent carbon regeneration is used. Following carbon treatment, wastewater is combined with other process waste, neutralized and clarified prior to entering a series of evaporation ponds, and ultimately is discharged to a navigable waterway.

The pollutants of interest for the KK pesticide process at Plant 17 are chlorobenzene and toluene; however, the plant has stated that no data currently exist to document the carbon system efficiency. Prior to final discharge both Pesticides JJ and KK were detected at a concentration of 0.002 mg/l.

Treatability Studies--A detailed review of activated carbon treatability studies was presented in the Development Document for Effluent Limitation Guidelines for the Pesticide Chemicals Manufacturing U.S. EPA 440/1-78/060-e, 1978f. Additional data received since 1978 are presented below.

Pilot studies were performed at Plant 18 to evaluate biological treatment effluent using a multimedia filter and four granular activated carbon columns in series. Data showed granular activated carbon can be applied to reduce total pesticide concentrations in the wastewater from 5.0 mg/l to less than 0.05 mg/l, a removal greater than 99 percent.

Plant 19 reported that in-house carbon isotherm studies show essentially complete removal of a pesticide at high carbon dosage levels. The plant currently incinerates its wastewater.

Pilot plant treatability studies were performed by ESE (Beaudet, 1979a) to determine removal of benzene, toluene, and six selected polynuclear aromatic hydrocarbons (naphthalene, acenaphthylene, fluorene, phenathrene, anthracene, and pyrene). The light hydrocarbon cracking units wastewater, normally pretreated by the plant for primary oil separation and solids removal, was further pretreated in the pilot plant by granular media filtration, then passed through multiple downflow, granular activated carbon columns. This study showed benzene and toluene were removed to below detection limits of 10 ug/l from multi-media filtered waste containing 21 to 71 mg/l benzene and 5 to 13 mg/l toluene. Influent levels as high as 24 mg/l total PNA's (defined as the sum of the individual polynuclear aromatic hydrocarbons monitored) were generally reduced to less than the detection limit of 10 ug/l in 83 percent of the samples analyzed.

Another treatability study by ESE (Beaudet, 1979b) was performed on hydrocarbon process wastewater to determine removal of 1,2-dichloroethane (EDC) and other chlorinated hydrocarbons (1,1,2-trichloroethane, carbon tetrachloride, trichloroethylene, and tetrachloroethylene). Results showed removal of EDC to below detection limits of 10 ug/l from a waste stream containing 14 to 950 mg/l EDC. The other chlorinated hydrocarbons monitored were adsorbed more readily than EDC.

Hydroscience (Toxler, 1980) reviewed the literature to gather performance data on the current use of activated carbon for treating wastewaters from the manufacture of organic chemicals. In general, it was reported that nonpolar, high molecular weight organics with limited solubility generally tend to be more readily adsorbed although there is an upper limit of molecular size above which adsorption is adversely affected. They report that branched-chain compounds are more adsorbable than straight-chain compounds. Aware Engineering (1979) also reported extremely good removals of high molecular weight compounds and erratic removal of several intermediate weight compounds such as naphthalene and dicyclopentadiene.

Hydroscience (Toxler, 1980) reports that the adsorptive capacity of the column could be increased with the increase of the bed depth (contact time). The report shows data illustrating the increase on activated carbon loading of sodium nitrophenol (SNP) with the increase in bed depth. This increase in loading is due to the greater saturation of the upper bed layers as the adsorption zone moves through the column.

Zogorski and Faust (1977) reported on the influence of various operational parameters on the removal of 2,4-dichlorophenol from water via fixed beds of granular activated carbon. One of the parameters studied was the height of the mass transfer zone. This parameter, as it increases, causes greater effluent bed contact time to be required to reduce an organic pollutant to a desired effluent concentration. It was found that the height of the mass transfer zone increased markedly:

1. With an increase in the linear velocity of the fluid,

2. With an increase in the size of the adsorbent, especially for carbon particle sizes greater than 0.65 mm, and

3. When the pH value of the solution exceeds the acidic dissociation constant of the adsorbate.

The effect of pH was also reported by Hydroscience (Toxler, 1980). Dissolved organics generally adsorb more readily at a pH which imparts the least polarity to the molecule. For example, phenol, a weak acid, can be expected to adsorb better at low pH, whereas amines, a weak base, exhibit better adsorption characteristics at higher pH. Influence of substituent groups or adsorbability is also important. For example: (1) Nitro--generally increases adsorbability, and (2) Aromatic ring--greatly increases adsorbability. Huang, et al. (1977) reported that the adsorption rate of phenols decreased in order of phenol, o-aminophenol, pyrocatacol, and resorcinol. For phenols, the adsorption capacity is greatly increased when an amino or hydroxo group at the ortho position is substituted.

Muruyama, et al. (1975) evaluated the effect of a two-step method that includes precipitation with lime followed by activated carbon to remove heavy metals from water. Pilot plants were dosed with metal concentrations in the influent of 0.5 mg/l for mercury and 5.0 mg/l for all other metals. The percent removals obtained are listed below.

Metal	Percent Removal	Metal	Percent Removal
Mn^{2+}	92-98.5	Pb^{2+}	96-99
Ni^{2+}	94-99.5	Cr^{3+}	95-99.5
Zn^{2+}	86-94	Cr^{6+}	94-98
Cu^{2+}	90-96	As^{3+}	80-85
Cd^{2+}	92-99.4	Hg^{2+}	92
Ba^{2+}	85-99		

Tertiary treatment of pesticides was studied (Saleh, 1982) at a 1-MGD pilot plant receiving biologically treated domestic wastewater. Activated carbon treatment was the most effective, with an empty bed contact time of 38 minutes providing nearly complete removal for aldrin, dieldrin, and 2,4-D esters. Chemical coagulation and multimedia filters did not consistently remove pesticide compounds.

Resin Adsorption

Adsorption by synthetic polymeric resins is an effective means to remove and recover specific chemical compounds from wastewater. Polymeric adsorption has been found to be applicable for all members of the phenol family as well as amines, caprolactam, benzene, chlorobenzenes, and chlorinated pesticides. The adsorption capacity of polymeric resins depends on the type and concentration of specific organics in the wastewater as well as the pH, temperature, viscosity, polarity, surface tension, and background concentrations of other organics and salts. For

example, a high salt background will enhance phenol adsorption, while increasing the pH will cause the adsorptive capacity of the resin to change sharply since the phenolic molecule goes from a neutral, poorly disassociated form at low and neutral pH to an anionic charged disassociated form at high pH. As with carbon adsorption, the adsorptive capacity increases as solubility decreases.

The adsorbants are hard, insoluble beads of porous, cross-linked polymer and are available in a variety of surface areas and pore-sized distributions. The binding energies of the polymers are normally lower than those of activated carbon for the same organic molecules, thereby allowing solvent and chemical regeneration and recovery to be practiced. Regeneration can be conducted with caustic, formaldehyde, or in solvents such as methanol, isopropanol, and acetone. Batch distillation of regenerant solutions can be used to separate and return products to the process.

Full-Scale Systems--Tables VI-9 and VI-10 present design and operating data for the four resin systems in the pesticide industry. Phenol, pesticide, and diene compounds are all being effectively removed by these systems. At least one system realized a significant product recovery via regeneration and distillation.

Plant 1 operates a resin adsorption treatment unit for wastewaters from its A pesticide process. After neutralization and settling in lagoons, the wastewater is filtered through anthracite and sand to remove suspended solids before entering one of two identical vessels filled with amberlite XAD-4® resin. An empty bed contact time of 7.5 minutes is provided at a flow rate of 4 gpm/ft^2 to remove Pesticide A. According to plant monitoring, the effluent Pesticide A concentration averages below 0.00123 mg/l, representing a 99.1 percent removal across the resin system. Verification monitoring by EPA contractors confirmed these results by detecting an effluent of 0.00067 mg/l over a 3-day period. During this same sampling the reduction of volatile priority pollutants such as carbon tetrachloride, chloroform, and chlorobenzene ranged from 28.4 to 59.4 percent, as shown in Table VI-10. The resin effluent is discharged to navigable waters.

The resin system at Plant 1 required regeneration only once in the period of one year. In that instance methanol was used as a regenerant and then was disposed as supplemental boiler fuel. Isopropyl alcohol may be used in the future as a regenerant; however, distillation of the solvent and recovery of pesticide have been ruled out as uneconomical.

Plant 2 designed and installed a resin adsorption system to remove Pesticide B and nitrated phenols from process wastewater. Wastewater is adjusted to pH 4.5 to favor the conversion of sodium nitrophenol (SNP) to para-nitrophenol (PNP), which is much less soluble in water and, therefore, is strongly attracted to the hydrophobic resin. In contrast, SNP is hydrophilic and is not attracted to the resin. The column is chemically regenerated with sodium hydroxide, thereby reconverting PNP

back to SNP so that greater than 99 percent can be recovered and reused.

Plant 2 conducted exhaustive studies on the removal of PNP from Pesticide B wastewater by adsorption on XAD-4® resins. They determined that after approximately 100 regeneration cycles the capacity of the resin leveled off at 3.3 lbs PNP/ft3 of resin. This was conducted at an influent PNP concentration of 1,000 mg/l with approximately 1 mg/l in the resin effluent. The wastewater was to be further treated by activated carbon; however, plant production of Pesticide B was discontinued.

Plant 3 constructed a resin adsorption unit in 1976 as part of an EPA demonstration grant for removal of pesticides from wastewaters. The system is preceded by wastewater settling and pressure filtration; approximately 15 minutes of detention time is provided at a flow rate of 3.5 gpm/ft^2. According to the final report for the demonstration grant (Marks, 1980), it is possible to maintain an average effluent level of 0.005 mg/l for Pesticides C and D with daily values not exceeding 0.01 mg/l. This would represent 95 to 99.5 percent removals. As shown in Table VI-10, between 85.1 and 92.2 percent of the dienes were removed. Volatile toxic organics such as carbon tetrachloride and toluene were removed in the 34.5 to 64.7 percent range. The resin effluent is neutralized and discharged to a POTW.

Although isopropanol was used to regenerate the resin beds at Plant 3 during the EPA demonstration grant, methanol has been found to be equally effective at lower cost. The alcohol can be successfully recovered for use in further regenerations by means of pot distillation, or it can be disposed as boiler fuel.

Plant 4 operates a resin system for the removal of phenols, Pesticide E, and other structurally similar pesticides. The process wastewater is pretreated by vacuum stripping to prevent toluene from building up in the regenerant. The wastewater is then filtered to remove suspended solids and cooled to prevent crystallization. One part of wastewater is mixed with two parts of recycled resin-treated effluent, then passed through one of two adsorbers containing XAD-4® resin with 15 minutes empty bed contact time. Columns last approximately 13 hours between regenerations. Both the plant and EPA contractors have sampled the resin system. As shown in Table VI-10, Pesticides E, F, and G were removed by 76.5 to 97 percent to levels of approximately 20 mg/l. Phenol and 2,4-dichlorophenol were reduced to approximately the 0.5 to 4 mg/l range. Toluene was shown to be reduced approximately 60 percent. Additional sampling/analysis of this system is being conducted by EPA Region IV. Resin-treated wastewater is neutralized and discharged to a POTW.

Plant 4 regenerates the resin with 1-1/2 bed volumes of methanol. The methanol and desorbed pesticides and phenols are distilled for product recovery and solvent reuse.

Treatability Studies--Aware (1979) conducted pilot scale studies with adsorbent resins at Plant 3. For a loading rate of 7.5 gpm/ft^2, and an empty bed contact time of 6 minutes, the following average removals were observed:

Parameter	Influent (ug/l)	Effluent (ug/l)	Percent Removal
Pesticide C	123	3.7	96.9
Pesticide D	40	2.1	94.7
Chlordane	283	2.1	99.3
Hexachlorocyclopentadiene	1,129	5.5	99.5
Heptachlor epoxide	11	0.2	98.2
Toluene	2,360	198	91.6
Chloroform	1,430	509	64.4
Carbon tetrachloride	20,950	8,670	58.6
Tetrachloroethylene	34	1.1	96.8
Naphthalene	529	100	81.1

Plant 5 is reported to be conducting bench scale treatability studies using XAD-4® resin for removal of phenols and pesticides in wastewater from their pesticide process.

Hydrolysis

In hydrolysis an hydroxyl or hydrogen ion attaches itself to some part of the pesticide chemical molecule, either displacing part of the group or breaking a bond, thus forming two or more new compounds.

The primary design parameter to be considered in hydrolysis is the half-life of the original molecule, which is the time required to react 50 percent of the original compound. The half-life is generally a function of the type molecule being hydrolyzed and the temperature and pH of the reaction. A detailed review of the theory of hydrolysis and laboratory data was presented in the BPT development document for pesticide chemicals (Jett, 1978). Additional full-scale and treatability data received since 1978 are presented below.

In assessing the treatability of pesticide compounds, hydrolysis should be considered a logical candidate for the following structural groups: amide type; carbamates; heterocyclic with nitrogen in the ring; phosphates and phosphonates; phosphorothioates and phosphorodithioates; thiocarbamates and triazines (Jett, 1978). According to this listing the use of hydrolysis can reasonably be expected to apply to at least one-third of all pesticides manufactured.

The effect of hydrolysis on priority pollutant compounds is not well documented. During EPA verification sampling at Plant 6, priority pollutant volatiles, such as methylene chloride and chloroform, and cyanide were either completely or partially removed. Since temperatures in hydrolysis basins sometimes exceed the boiling points of many of the

volatile priority pollutants, it can be inferred that they will be transferred to a vapor phase unless basins are enclosed.

Full-Scale Systems--Table VI-11 presents the design data for nine plants employing full-scale hydrolysis treatment systems. Table VI-12 presents operating data for these same systems. Detention time up to ten days is used in the industry to reduce pesticide levels by up to 99.8 percent resulting in typical effluents less than 1 mg/l.

Plant 1 hydrolyzes washdown and rainwater runoff from its A pesticide process. Wastewater is adjusted with caustic to a pH greater than 9.0 and detained in one of two identically sized batch hydrolysis basins for anywhere from 4.5 to 31.0 days. As shown in Table VI-12, the Pesticide A content is reduced an average of 99.8 percent, from 3,300 mg/l to 5.49 mg/l. The basin effluent is neutralized and then spray irrigated with no discharge to navigable waters.

Plant 2 operates an hydrolysis basin for wastewater from its B pesticide process. A pH less than 1 is maintained for 8 to 15 days in order to reduce the Pesticide B concentration by 99.9 percent from 57 mg/l to 0.049 mg/l. The basin effluent is then combined with other plant wastewaters and sent to a biological treatment plant for subsequent direct discharge.

Plant 3 operates a hydrolysis basin for wastewater from its C pesticide process. The wastewater is detained in one of two identical batch basins for approximately 3 hours at pH 12.7. Steam is added to raise the wastewater temperature to approximately 46°C. As a result, Pesticide C is reduced from 93.7 to 97.9 percent, from approximately 27 mg/l to between 1.7 and 0.56 mg/l. The basin effluent is combined with other plant wastes and sent to a biological treatment system prior to subsequent direct discharge.

Plant 4 hydrolyzes wastewater from its D and E pesticide processes. The acidic wastewater is hydrolyzed by passing it through a limestone pit and two parallel holding tanks where the pH is adjusted to between 7 and 10. After 3 to 5 hours detention in the holding tanks it is further hydrolyzed in four parallel aeration basins for a period of three to five days. Pesticides are reduced by more than 99.9 percent, from 12.2 mg/l to <0.01 mg/l prior to discharge to a POTW.

Plant 5 operates hydrolysis treatment units for wastewater from 11 of its pesticide processes. A maximum of six vessels are used at any one time, four on a continuous basis, and two on a batch basis. Because the units are relatively small (1,200 to 12,000 gallons), high pH (up to 13+), and high temperature (up to 100°C) is used to hydrolyze pesticides rapidly (within 1 to 4 hours). As shown in Table VI-12, actual plant wastewater sampling demonstrates that all pesticides can be reduced below 1 mg/l (Pesticide K would require an additional 45 minutes detention). After pretreatment by hydrolysis, pesticide wastewater is combined with other plant wastes and sent to biological treatment for subsequent direct discharge.

Plant 6 uses two separate hydrolysis treatment units for wastewaters from its pesticide processes. The Pesticide Q hydrolysis system is a proprietary unit designed to remove more than 95 percent of all pesticide compounds structurally similar to Pesticide Q. Actual verification analyses of this unit were inconsistent with plant and EPA expected results; therefore, a longer term re-sampling is being planned.

Four other pesticides are hydrolyzed at Plant 6 for 12 hours at 43°C while the pH is maintained between 12 and 14. These pesticides are removed to below their detection limits according to plant monitoring records. After pretreatment by hydrolysis, all pesticide wastewaters are sent to a biological treatment system for subsequent direct discharge.

Plant 7 used both alkaline and acid hydrolysis to remove pesticides from their W and X pesticide wastewaters. A pH of 10 to 12 is maintained for 80 minutes at 104°C in the first hydrolysis unit, while a pH of 4 to 6 is maintained for 50 to 60 minutes at 104°C in the second unit. Pesticide W is reduced from 55 mg/l to nondetectable levels in the system; Pesticide X is reported by the plant to hydrolyze more readily, although no analyses are currently available. After pretreatment by hydrolysis the wastewater is chemically oxidized and then evaporated with no discharge to navigable waters.

Plant 8 operates a hydrolysis basin for wastewaters from its Y pesticide process. Wastewater is maintained at pH 9.0 for 19 hours at 75°C, during which time the Pesticide Y is reduced from 720 to 90 mg/l. Plant experimental data show that by increasing the temperature to 85°C and increasing the pH to 10.0, the half-life for Pesticide Y would change from 6 to 2 hours. Under such experimental conditions the hydrolysis basin effluent would be approximately 1 mg/l. After pretreatment by hydrolysis the effluent is combined with other plant wastes and sent to activated carbon treatment for subsequent direct discharge.

Treatability Studies--Plant 9 reports that it is planning to modify its treatment system to use hydrolysis for wastewaters from their pesticide processes. Lab data on which these plans are based show percent removal of pesticides to be 97 and 93, respectively, at specific conditions of pH and temperature.

Plant 10 reports that the following pesticides will hydrolyze under alkaline conditions: Z, AA, BB, CC, and DD. Table VI-13 contains hydrolysis data for these compounds.

Plant 11 states that organophosphate pesticides will hydrolyze in warm alkaline water.

Studies on triazine pesticides not reported in the BPT Development Document (Jett, 1978) are presented in Table VI-14. In general, acid hydrolysis provides sufficient degradation to allow feasible full-scale design of systems removing pesticides through 10 half-lives (99.9 percent).

Kinetic studies conducted by Wolfe (1976) indicate second order rate constants for the hydrolysis of atrazine with sulfuric and with hydrochloric acid in waters. The reported values at pH 0.5 and 40°C plus or minus 0.02°C are:

Hydrochloric--(6.9 plus or minus 0.6) x 10^{-5} $kM^{-1}s^{-1}$
Sulfuric--(1.9 plus or minus 0.2) x 10^{-4} $kM^{-1}s^{-1}$

Half-life for atrazine at the same conditions were calculated as:

Hydrochloric--529 plus or minus 38 minutes
Sulfuric--192 plus or minus 18 minutes

Studies performed by Armstrong, et al. (1967) on atrazine showed that the pesticide hydrolysis follows first order kinetics at constant pH, but the rate is also pH dependent. Authors reported hydroxyatrazine as the primary hydrolysis product of atrazine and that it is quite resistant to microbial degradation. However, Kearney, et al. (1969) reported a decrease in phototoxicity proportional to a decrease in the actual concentration of the s-triazine, thereby demonstrating that degradation products do not have herbicidal properties.

Munnecke (1976) reported that seven commonly used organophosphate insecticides were hydrolyzed at rates significantly higher (40 to 1,005 times faster) than chemical hydrolysis through the use of enzymes. Parathion metabolites, such as p-nitrophenol, did not significantly influence enzyme activity. The optimum pH range for enzymatic hydrolysis of the eight organophosphate pesticides range from 8.5 to 9.5 with less than 50 percent activity at pH 7. Munnecke notes that the ability of cell-free enzymes to degradate pesticides has been demonstrated for phenylureas, phenylcarbamates, acylanilides, and phenol herbicides. Through culture enrichment and enzyme production techniques the hydrolysis kinetics on these pesticides may be demonstrated on actual pesticide wastewaters in full scale applications.

In 1978, Munnecke reported that the application of soluble or immobilized enzymes can degrade toxic pesticides to less toxic metabolites. In laboratory studies on parathion hydrolyze activity an immobilized enzyme was stabilized at a half-life of 280 days.

Incineration

Incineration is a controlled process for oxidizing solid, liquid, or gaseous combustible wastes to carbon dioxide, water, and ash. In the pesticide industry thermal incinerators are employed to destroy wastes containing compounds such as: hydrocarbons (toluene); chlorinated hydrocarbons (carbon tetrachloride, ethylene dichloride, etc.); sulfonated solvents (carbon disulfide); and pesticides. Greater than 99.9 percent pesticide removal, as well as greater than 95 percent BOD, COD, and TOC removal, can be achieved provided that sufficient temperature, time, and turbulence are utilized. It should be noted that sulfur and nitrogen-containing compounds will produce their corresponding

oxides and should not be incinerated without considering their effects on air quality. Halogenated hydrocarbons may not only affect the air quality but may corrode the incinerator. Also, it is not recommended that organo-metallic compounds containing cadmium, mercury, etc., be incinerated due to the potential for air and solid waste contamination.

Full-Scale Systems--Table VI-15 provides design data for 14 pesticide manufacturers using incineration for flows ranging up to 39,000 gallons per day.

Plant 1 uses an incinerator to dispose of the centrifugal filtrate and floor washings from the A pesticide process area. Since other nonpesticide organic residues are also atomized by the two brick-lined incinerators, only 5.7 percent of the wastewater processed is attributed to Pesticide A. The residues sustain combustion in the reactors operating at 1,400°C. The heat value of waste is estimated at 98,000 BTU per gallon. As shown in Table VI-15, the incinerator capacity is 30 to 35 million BTU per hour for both reactors operating in parallel using a common scrubber. Steam is continuously fed to the reactors to supply hydrogen to form hydrochloric acid. Because these residues are highly chlorinated, the thermal degradation yields carbon dioxide and hydrochloric acid. The off-gas is water quenched in a carbon block spray tower and water scrubbed in the carbon block, ceramic Intalox packed tower before venting to atmosphere. The dilute hydrochloric acid from the scrubber system is neutralized and discharged to a municipal treatment system. Prior to incineration, toluene/orthochlorotoluene and Pesticide A raw materials are found at levels of 24 and 8 mg/l, respectively; however, there are no data available for the scrubber discharge waste stream.

Plant 2 has a Trane thermal incinerator to oxidize high strength wastes from six pesticide processes. Sixty percent of incinerator use has been devoted to pesticides; however, on only two occasions for testing purposes has pesticide wastewater been oxidized. In both instances the pesticide wastewaters were mixed with total plant effluents. Therefore, no pesticide data exist for the scrubber discharge.

The incinerator capacity is 36 million BTU per hour and will process an average pesticide wastewater volume of 18,000 gallons per day. The wastewater characteristics for the pesticide portion of the incinerator influent are as follows: 2,700 mg/l phosphorus; 6,200 mg/l sulfur; 60,000 mg/l BOD; 150,000 mg/l COD; and 50,000 mg/l TOC. The incinerator at this plant is planned to be an alternative to ocean disposal.

Plant 3 uses two on-site incinerators to oxidize process off-gases and waste organic liquid streams. One incinerator has a capacity of 8.7 million BTU per hour and is designed to operate in excess of 871°C. This combination liquid-vapor incinerator is entirely devoted to H, I, and J pesticides. The flue gas scrubber effluent is combined with the general aqueous effluent from these pesticides prior to entering the treatment system. At present there are no available data to document

removal; however, during the EPA verification visits it was estimated by plant personnel to remove all pesticides.

The second pesticide incinerator at Plant 3 has a capacity of 20 million BTU per hour. This two-stage, John Zink oxidizer is designed to handle effluents with high chemically-bound nitrogen content maintaining acceptably low levels of NOx emissions. This unit is totally dedicated to the K pesticide operation. The design raw waste load data is as follows: TOC 33.0 lbs/1,000 lbs production and TOD 207.8 lbs/1,000 lbs production.

Plant 4 operates two thermal oxidizers to dispose of wastewater from six pesticide products. One of the two oxidizers was built by the John Zink Company and has a rated heat release capacity of 35 million BTU per hour. The second oxidizer has a heat release capacity of 70 million BTU per hour and was built by the Trane Thermal Company.

The thermal oxidizers at Plant 4 were designed to dispose of two different wastes. The first primary feed stream consists of approximately 95 percent organics and 5 percent water. The second stream consists of approximately 5 percent organics and 95 percent water. The energy generated in the burning of the primary stream is anticipated to vaporize all water in the secondary stream and to oxidize all of the organics present. Wastes from the O and P pesticide processes currently use 0.55 and 4.68 percent, respectively, of the incinerator capacity. As shown in Table VI-15, available information shows that pesticides incinerated have a combined wastewater volume of 0.0074 MGD.

The incinerator scrubber water at Plant 4 was sampled during the EPA verification program. The scrubber effluent is discharged to the tertiary treatment system at a rate of 0.992 MGD. Cyanide was found at a level of 0.00633 mg/l or 0.0239 pound per day in the incinerator scrubber water. No other conventional or priority pollutants have been measured to determine incinerator efficiency.

Plant 5 operates an incinerator with a capacity of 3,000 BTU per thousand pound feed to dispose of wastes from the manufacture of Pesticides R, S, T, U, and V. Approximately 0.05 MGD of T pesticide wastewater is incinerated. The waste stream from the extraction phase of Pesticide S production is incinerated. This stream is 2,000 gallons per day. Waste streams from the reaction processes of Pesticides R and V are also incinerated. Spills, leaks, and scrubber discharge from the U pesticide process are incinerated at a rate of 500 gallons per day.

The incinerator feed at Plant 5 separates into an aqueous and organic phase. The water content of the aqueous phase is approximately 82 percent. At present, 22 percent of the incinerator feed contains pesticide active ingredients. All incinerator feed originates in pesticide operations. Incineration at Plant 5 effectively reduces levels of the priority pollutants methylene chloride, benzene, and toluene, as well as controlling odor and COD.

Plant 5 incinerator feed data indicate pesticide levels to be up to 130 pounds per thousand pounds of production. As shown by effluent data from the incinerators stack gas water scrubbers, pesticide removal is from 50 to 99.9 percent. Traditional parameters average 95.9 percent destruction. Nitrogen destruction averages 63.9 percent. A possible explanation for this low destruction is that although initial ammonia may be destroyed, partial destruction of organic nitrogen to ammonia nitrogen results in a significant amount of ammonia in the scrubbing liquid. The effluent from the stack gas water scrubber combines with other plant wastes before biological treatment.

Plant 6 uses an on-site incinerator to treat organic waste from the manufacture of Pesticide W. The organic waste contains all of the reaction byproducts as well as sufficient methanol to keep it fluid. Approximately 5.5 million pounds of incinerator feed was generated in 1977 averaging 10.4 percent Pesticide W, 33 percent methanol, and 56.6 percent byproducts.

The daily flow of Pesticide W organic waste into the incinerator at Plant 6 is 2,000 gallons per day. The incinerator capacity is rated at 10 million BTU per hour and operates between 1,370 and 1,540°C. The dwell time for this unit is 0.4 to 0.6 seconds. There are no scrubber or wastewater discharges from the incinerator. Exhaust gases are vented to the atmosphere. No data currently exist to document the incinerator efficiency for this halogenated aromatic compound.

Plant 7 operates three thermal oxidizers to dispose of organics which have been skimmed off process wastewater from eight pesticide effluents. The incinerators were installed to remove pesticides as well as benzene and toluene before discharge by deep well injection.

As shown in Table VI-15, two of the incinerators at Plant 7 have capacities of 9 million and 12 million Btu per hour, respectively. The pesticide volume oxidized for both incinerators is 276 gallons per day. The average pounds per day incinerated for pesticides and volatiles is shown below:

Organic Liquid Waste	Pounds per Day
Benzene	414
Toluene	322
Pesticide X	23
Other Pesticides (Y-EE)	968
Byproducts	576

Approximately 15 to 20 percent of the units are devoted to the liquid waste.

The third incinerator at Plant 7 mainly oxidizes waste from the X pesticide process. Approximately 60 percent of the unit is devoted to liquid waste. Five hundred and fifty-two gallons per day of pesticide wastewater is incinerated averaging 230 pounds of Pesticide X,

1,705 pounds of toluene, and 2,672 pounds of byproducts. This unit operates at a rate of 20 million BTU per hour.

All incinerators at Plant 7 operate at 815°C with an exhaust stack height of 100 feet.

Plant 8 operates a waste gas incinerator which uses FF pesticide waste as supplemental fuel since its heat value is approximately 120,000 BTU per gallon. The source of this waste is still bottoms from the FF pesticide distillation process. The rated capacity of the incinerator is 5 million BTU per hour. Approximately 1,000 gallons per day of FF pesticide waste is fed to the incinerator. There is no air pollution control equipment on the incinerator. The plant has estimated that no FF pesticide residue is in the process wastewater from the plant which is discharged to a navigable waterway.

Plant 9 operates a J.D. Thorpe incinerator for the destruction of wastes from the manufacture of Pesticides GG and HH. The incinerator is devoted to only pesticide wastes. Organic wastes from the HH pesticide plant, aqueous and organic solvent wastes from the GG pesticide plant, and some wastes from the formulations plant are injected into a firebox, operating at 870 to 3,180°C, with approximately two seconds residence time. The heat release capacity is 76.7 million BTU per hour.

The 39,000 gallons per day of GG pesticide waste which is incinerated by Plant 9 is estimated to be composed of the following:

Compound	mg/l
TOC	35,800
Nitrogen	29,600
Chlorine	39,400
Phosphorus	4,850
Sulfur	33,200

The HH pesticide process at Plant 9 feeds 1,000 gallons per day of waste to the incinerator. The following are the characteristics of HH pesticide wastewater:

Compound	mg/l
TOC	4,140,000
Chlorine	301,000
Sulfur	67,900

The source of the high TOC was found to be the HH pesticide solvent bleed stream which is primarily toluene.

The incinerator at Plant 9 was designed to oxidize organic compounds to water and carbon dioxide. Sulfur, chlorine, and phosphorus are converted to sulfur dioxide, hydrochloric acid, and phosphorus pentoxide.

The hot exhaust gases are quenched by a recirculating neutral salt water solution, followed by scrubbing in a venturi. The venturi operates at pressure drops up to 100 feet of water to remove phosphorus pentoxide. The cooling tower and heat exchanger cool down the exhaust gases from 87.8 to 71.7°C. Over 50 million BTU per hour are recovered from the condensation of water in the stack gases. The recirculating scrubber solution, approximately 0.27 MGD, is neutralized with sodium hydroxide. Solids that remain are sodium sulfite, sodium chloride, and sodium phosphate. Sodium sulfite is then oxidized to sodium sulfate in an air oxidizer prior to direct discharge.

The average wastewater characteristics from the incinerated and air oxidized effluent at Plant 9 are shown below.

Compound	mg/l
Pesticide HH	0.0026
Pesticide GG	Not detected
Paraquat*	Not detected
Toxaphene*	Not detected
Captan*	0.0017
Chlordane*	0.00013
Arsenic	2.0
Zinc	<3.5
NH_3-N	125
Zinc	1.77

* Not manufactured at time of sampling.

Plant 10 operates an on-site Trane thermal oxidizer to dispose of organic and aqueous waste from the manufacture of Pesticide II. Approximately 0.024 MGD of wastewater is oxidized by this unit which is entirely devoted to pesticide wastes. The heat release capacity is 48 million BTU per hour. The incinerator off-gases are passed through an alkaline wet scrubber and into an oxidation tower. The incinerator separator liquid is drained off, mixed with lime, and discharged to a sludge lagoon. The lagoon effluent and oxidation tower condensate averaging 0.09 MGD are combined with other plant wastes. The plant has stated that there are no data available for the incineration effluent at Plant 10 which is discharged to a navigable waterway.

Plant 11 incinerates all of the waste produced by the JJ pesticide facility. Both aqueous waste from the aminolysis reaction and nonaqueous still residue from distillation are oxidized. The average aqueous waste flow from the process is approximately 2,900 gallons per day. The incinerator influent contains about 95 to 97 percent water, 1 to 3 percent high molecular weight organics, and 1 to 3 percent inorganic salts. As shown in Table VI-15 the rated capacity of the oil-fired incinerator is 12 million BTU per hour; however, there is no useful heat value from the aqueous waste stream. At present, the incinerator is used only to dispose of process wastewater from Pesticide JJ. Air pollution is controlled by a caustic soda enriched

water scrubber. The plant has stated that no data are available for the wet scrubber effluent.

Plant 12 is reported to use an on-site incinerator for aqueous waste from the chlorinator step of the KK pesticide process. No additional details on this system are currently available. Waste from another pesticide product, which cannot be recovered to the process, is used as boiler fuel at Plant 12, thereby allowing no wastewater discharge from this process.

Plant 13 uses two incinerators to dispose of organic waste and vent gases from the LL and MM pesticide processes. In addition, aqueous waste from the toluene purification step of the LL pesticide process is oxidized. Periodically the pressure filtration treatment system contributes organic waste to the incinerator feed.

As shown in Table VI-15, one incinerator at Plant 13 degrades 11.1 gallons per day of LL pesticide waste and has a 100-foot exhaust stack. The incinerator capacity is rated at 14 million BTU per hour.

A second incinerator at Plant 13 combines wastes from both the LL and MM pesticide processes. Pesticide MM contributes 105 gallons per day, and Pesticide LL provides 7.6 gallons per day of waste to this 10-million BTU per hour thermal oxidizer. This incinerator has a 100-foot exhaust stack for air pollution control. At present the plant has stated that there are no available data to document the efficiency of these incinerators prior to discharge of process wastewaters by deep well injection.

Plant 14 has installed an incinerator to destroy nonconventional pesticide NN, which is contained in aqueous plant process wastes. Performance testing showed that NN pesticide destruction efficiencies in excess of 99.9 weight percent were achieved at a permitted design feed rate of 6 gpm, oxidizer temperature of 1,800°F, and residence time of 2 seconds. Additional testing showed that 99.9 percent pesticide destruction could also be achieved, if permitted, at feed rates up to 8.4 gpm, oxidizer temperatures as low as 1,427°F, and residence time as low as 1.8 seconds. The 9.5 million BTU per hour incinerator was found to achieve 99.9 percent pesticide destruction under acceptable conditions of combustion efficiency, stack opacity, and sulfur dioxide emissions.

Wet Air Oxidation (WAO)

Wet air oxidation is a liquid phase oxidation and/or hydrolysis at elevated temperature and pressure. The process can be used as a pretreatment step to destroy toxics ahead of conventional biological treatment, or to regenerate powdered activated carbon from a biological treatment system. Products of oxidation stay in the liquid phase and do not create a secondary air pollution problem. The process can substantially reduce COD of toxic waste streams. When raw waste loads reach a level of 20,000 to 30,000 mg/l COD, the process becomes thermally

self-sustaining. Phenols, cyanide, nitrosamines, dienes, and pesticides have been shown to be effectively removed by WAO.

There are no full-scale WAO systems operating in the pesticide industry today.

Treatability Studies--Wilhelmi and Ely (1975) reported that demonstration work on the end of pipe effluent from a pesticide manufacturer, using WAO, reduced the COD/BOD ratio from 3.7:1 to 1.2:1. They also reported that cyanide, in concentrations between 500 and 3,000 mg/l, at an acrylo nitrile plant in Japan, has been reduced by over 99.9 percent along with a 95+ percent reduction in COD. In general, they noted that a two-step process of partial oxidation and detoxification by WAO, followed by some type of biological process, can typically result in COD reductions from 55,000 to 300 mg/l.

Wilhelmi and Ely (1976) and Randall and Knopp (1978) reported on the destruction of phenols (more than 99.8 percent) by WAO. It was noted that during the oxidation process higher molecular weight compounds are preferentially oxidized to lower molecular weight intermediate products. High oxidation temperatures, and the use of copper catalysts at lower temperatures, were proven effective in phenol destruction.

Wilhelmi and Knopp (1978) reported that the WAO system used at the Louisville, Kentucky sewage plant to detoxify spills of hexachlorocyclopentadiene reduced the concentration of the toxic chemical from 6,000 mg/l to 420 mg/l.

WAO tests (Wilhelmi, 1979) showed reductions of nitrosodipropylamine from 170 mg/l to 2 to 3 mg/l and for N-nitrosomethylamine, reductions from 400 mg/l to 50 ppb.

Zimpro, Inc. (1980) reported on the destruction of pesticide chemicals by WAO. A summary of the pesticides evaluated (identified by structural group) follows.

A. Destroyed at 200°C

* Most of the amide and amide-type pesticides

* Carbamate pesticides

* Urea pesticides, monuron and siduron

* Heterocyclic pesticides with nitrogen in the ring

* The uracil pesticides, bromacil and terbacil

* Phosphorothioate and phosphorodithioate pesticides

* Most of the halogenated aliphatic and aromatic pesticides (except trichlorobenzene, PCNB, dichlorobenzene, ortho, and para)

B. Destroyed at 240°C to 275°C

* All the tested pesticides in the nitro structural group

* The triazines pesticides

* Most of the urea pesticides (except monuron and siduron)

Zimpro, Inc. (1980) also reported that in pilot plant tests, a wastewater composite of about 40 actual pesticides showed a 99+ percent pesticide destruction and 85 percent COD reduction by WAO.

Solvent Extraction

The use of solvent extraction as a unit process operation is common in the pesticide industry; however, it is not widely practiced for the removal of pollutants from waste effluents. It should be considered as a potential treatment alternative to steam stripping and adsorption systems with product recovery. Solvent extraction is most effectively applied to segregated process streams as a roughing treatment for the removal of priority pollutants such as phenols, cyanide, and volatile aromatics.

Full-Scale Systems--Plant 1 uses solvent extraction for the removal of 2,4-dichlorophenol from pesticide process wastewaters. As a result, Plant 1 has reported that 2,4-dichlorophenol is reduced by an average of 98.9 percent, from 6,710 to 74.3 mg/l.

Treatability Studies--Phenol removal by solvent extraction has been used extensively for the treatment of refinery and coke byproduct waste (Mulligan, 1976). Removals generally range from 90 to 99.9 percent with effluent levels of 1 to 4 mg/l from a feed of 1,500 mg/l when high distribution coefficient solvents were used.

Solvent extraction removals of 97 percent for benzene, ethylbenzene, and TOD have been reported (Earhart, et al., 1977) using isobutylene as the solvent.

Membrane Processes

Reverse osmosis systems place wastewater under pressure in the presence of an osmotic membrane to remove solutes from solution. Molecular size, valency, temperature, pH, suspended solids, and pressure may affect the rejection rate for the membrane. Membrane materials used are cellulose acetate, polymers such as polyamides and polyureas, dynamic membranes using hydrous zirconium oxide and polyacrylic acid, and inorganic membranes.

Ultrafiltration systems achieve similar removal of solutes from solution based primarily on molecular size. Modern ultrafiltration membranes are made from a variety of noncellulosic synthetic polymers such as nylon, vinyl chloride-acrylonitrile copolymers, polysulfone, polyvinylidene, etc.

Although no membrane processes are used in the pesticide industry, their application has been demonstrated in the metal industry for recovery of zinc and copper, in the textile industry for recovery of polyvinyl alcohols and mineral oils as well as for removal of dyes, and in the pulp and paper and food industries (Mulligan, 1976).

The Development Document for the Coil Coating Industry (U.S. EPA, 1980c) reported the following data from full-scale systems using membrane filtration to remove precipitated metals from wastewater.

	Plant 1			Plant 2		
Metal	In (mg/l)	Out (mg/l)	Percent Removal	In (mg/l)	Out (mg/l)	Percent Removal
Copper	18.8	0.043	99.8	8.0	0.22	97.3
Zinc	2.09	0.046	97.6	5.0	0.051	98.9

Treatability Studies--CARRE (1977) conducted screening tests on textile wastewater to review the rejection by membrane of various known toxic chemicals and indicators. Eight different types of membrane and 14 parameters (BOD, COD, TOC, dissolved solids, volatile solids, color, phenol, mercury, manganese, iron, nickel, chromium, zinc, copper) were investigated. Rejection data for some specific compounds by Selas Dynamic Zr(IV)-PAA membrane follows.

Parameter	Percent Rejection	Concentration (mg/l)	No. of Data 90-100%
COD	71-99	1600-7100	27 out of 35
BOD	74-99	25-2300	29 out of 38
TOC	82-98	175-2000	26 out of 32
Phenol	86-100	0.66-315	4 out of 7
Zinc	94-99	2.1-18	13 out of 13
Copper	92-99	1.5-5.5	14 out of 14
Nickel	80-98	0.7-3.87	7 out of 10

Rejection data for the cellulose acetate membrane demonstrated good removals at high concentrations over wide fluctuations in pH. These results agreed closely with available literature data.

Bench tests and an extensive literature search were made by Cabasso, et al. (1975) to determine the applicability of trace organic solutes removal from drinking water by membrane separation. The five membranes evaluated were cellulose acetate, cellulose acetate butyrate, ethyl cellulose, polyamide, and polyurea (NS-1) with the latter two proving most effective. The authors concluded that treatment by reverse osmosis

with further treatment by an osmotic concentrator is a reasonable approach. The authors further concluded that high water-solute coupling occurs in transport.

Hyperfiltration treatability studies are currently being conducted on pesticide wastewaters by EPA.

Biological Oxidation

Aerated lagoon, activated sludge, and trickling filter systems are widely used throughout the pesticide industry to remove organic pollutants measured by parameters such as BOD and COD. As shown in Table VI-16, there are: (1) 14 aerated lagoon systems with detention times ranging from approximately 2 days to 95 days, (2) 13 activated sludge systems with detention times from 7.15 to 79 hours, and (3) 4 trickling filter systems.

Conventional and nonconventional pollutant operating data for these systems are presented in Table VI-17. BOD removals ranging from 87.4 to 98.8 percent were achieved at major industry biological systems such as Plants 3, 4, 7, 9, 11, 13, and 26. COD removals at these same plants ranged from 60.5 to 89.7 percent. The only major group of pesticides not previously regulated for BOD and COD are the triazines; average BOD and COD removals are approximately 94.2 and 64.8 percent, respectively, for Plants 3, 7, and 9, which produce triazines.

Priority pollutant and nonconventional pollutant pesticide (manufactured pesticide) removal in biological systems is described below. The mechanism of pollutant removal may be one or more of the following: (1) biological degradation of the pollutant, (2) adsorption of the pollutant onto sludge which is separately disposed, or (3) volatilization of the pollutant into the air.

It is well documented that biological systems can be acclimated to wastewaters containing significant concentrations of phenols. For example, Plant 21 operates an aerated lagoon system removing phenol by >93.8 percent from 61.8 to <3.84 mg/l. Plant 16 operates an aerated lagoon with hydrogen peroxide added, which reduces phenol by 99.8 percent from 1,100 mg/l to 2.03 mg/l. Plant 5 reduces 4-nitrophenol by 94.7 percent from 203 mg/l to 10.7 mg/l. Plant 6 reduces 4-nitrophenol by >99.8 percent from 461 mg/l to <1.0 mg/l. Plant 2 reduces 2,4-dinitrophenol by 95 percent from 7.91 mg/l to 0.397 mg/l. In such cases as described above, biological systems achieve priority pollutant phenols removal similar to that of activated carbon, resin adsorption, and chemical oxidation pretreatment systems.

The fate of priority pollutant phenols which reach biological systems, after pretreatment, at approximately 1 mg/l or below is a phenomenon of importance which requires further study. As shown in Table VI-17, the following actual removals have been observed in the pesticide industry:

Priority Pollutant	Percent Removal with Raw Load Below 1 mg/l
Phenol	84.4-96.5
2-Chlorophenol	>83.9
2,4-Dichlorophenol	93.8-97.6
2,4,6-Trichlorophenol	4.5 or less
Pentachlorophenol	39.6-41.0

Data from wood preserving plants in the Timber Industry (ESE, 1978) indicate that pentachlorophenol is removed through biological systems as follows:

Plant	Influent	Effluent	Percent Removal
33	158.0	0.907	99.4
34	1.2	0.032	97.3
35	22.3	0.21	99.1
36	2.7	0.069	97.4

As shown in Table VI-17, approximately 50 percent of the cyanide at a 1 mg/l concentration entering the biological systems at Plants 3 and 13 is removed. Additional data from Plants 3, 7, and 9 indicate that cyanide removals are related to influent concentration, i.e., greater than 50 percent removal is experienced for raw wasteloads greater than 1 mg/l, and less than 50 percent for raw wasteloads less than 1 mg/l.

Air stripping of volatile priority pollutants in biological systems is a phenomenon which has received some study as described in Section VIII (Nonwater Quality Aspects). In general, these pollutants are removed from above about 1 mg/l down to their detection limits of <0.005 to <0.01 mg/l. Actual data from biological systems treating pesticide wastewater are summarized below from Table VI-17:

Pollutant Group	Percent Removal Range	Percent Removal Average
Volatile Aromatics	56.5-99.9	94.6
Halomethanes	22.6-98.5	58.3
Haloethers	90.9	90.9
Chlorinated Ethanes(ylenes)	9.1-96.3	63.0
Polynuclear Aromatics	>84.8	>84.8

Priority pollutant metals which can be traced to process sources in the pesticide industry are copper and zinc. Table VI-17 shows copper and zinc removals in biological systems to be about 50 percent at influent concentrations of 1 mg/l or less. These metals are adsorbed onto sludge since they are not volatile or biodegradable.

Priority pollutant dienes are not currently biologically treated in the pesticide industry. Due to their relatively low solubility, dienes are

not expected to be biodegraded or volatilized (Strier, 1979), but rather like metals will adsorb on sludge.

Pesticides are removed in biological systems to varying degrees, based on the characteristics of the individual compound. It can be observed from Table VI-17 that biological systems such as Plants 2, 7, and 13 which are receiving pesticides at approximately 1 mg/l, are achieving removals in excess of 50 percent.

Treatability Studies--Results from bench scale treatability studies performed by Plant 37 showed that a pesticide in concentrations up to 3,000 mg/l did not inhibit aerobic degradation of sewage at typical aerator food-to-mass ratios.

Plant 5 conducted bench-scale biological studies to determine the removal of COD from pesticide wastewater. An average COD removal of 57 percent was achieved in an aerated lagoon with no equalization and 40 days retention. A pilot plant with equalization and 20 days retention time achieved an average COD removal of 56 percent. An activated sludge bench unit with 5 days retention and no equalization achieved an average removal of 44 percent. Plant 5 determined that equalization of 5 to 10 days should allow the activated sludge system to achieve 57 percent COD removal.

After conducting bench-scale and pilot-plant treatability studies, as well as in-plant hydraulic/sampling surveys, Plant 38 has concluded that out of ten alternative schemes to ocean disposal, biological treatment of selected wastes, coupled with evaporation and thermal oxidation of high strength wastes, have been selected.

Plant 39 reported that it will be replacing its activated carbon treatment system for biological oxidation for the treatment of all plant wastes. Startup was planned for after June 1979.

Plant 16 reported phenol degradation with a strain of aspergillus bacteria.

Plant 40 conducted a bench-scale activated sludge study of wastewater from a pesticide process. Over 99 percent destruction of this pesticide was achieved with effluent levels of less than 1.8 ug/l.

Plant 28 has conducted pilot-scale treatability studies on the pesticide consisting of a 20-gallon aerated lagoon with approximately 15 days detention time along with gravity classification and flocculation. COD removal of 83 percent and BOD removals of 97.5 percent was reported.

Plant 29 reported that spent pesticide fermentation beer, sampled in March 1978, did not inhibit biological activity when added to a bench scale activated sludge unit.

Monnig, et al. (1979) reported results of a bench-scale activated sludge system where carbaryl wastewater was diluted with nine parts of

municipal wastewater. Carbaryl, toluene, and COD were all reduced 90 percent or greater. The influent concentration of the wastewater was the following: Toluene, 160 mg/l; COD, 4,100 mg/l; Carbaryl, 4.3 mg/l; and NH_3-N, 158 mg/l. Carbaryl or alpha-naphthal (which was reported as the hydrolysis product for carbaryl) was not detected above 0.5 ug/l in the test unit effluent. Data indicated that carbaryl is readily degraded in activated sludge systems.

Saldick (1975) reported cyanuric acid is removed from aqueous chemical plant wastes by treatment of the wastes with active bacteria, under anaerobic conditions, while preferably holding pH approximately 5.0 to 8.5 at ambient temperature.

Petrasek, et al. (1981) conducted a pilot-plant study to evaluate the behavior and fate of the volatile organic priority pollutants in a conventional municipal wastewater treatment plant. It was determined that POTW removals of these pollutants were greater than or equal to 95 percent with effluent levels less than 1 ug/l in most cases. Exceptions were 1,1,2-trichloroethane (69 percent) and dibromochloromethane (73 percent). It was also found that the volatile organic priority pollutants do not generally partition strongly to the sludge. A direct relationship was observed between a compounds tendency to partition to the sludge and the sludge's octanol/water partition coefficient. Significant quantities of some of the compounds were also found in the off-gases from the aeration basin. Removal by primary clarification and activated sludge treatment for specific compounds to be regulated in the pesticide industry were as follows:

Compound	Percent Removal
Benzene	99
Chlorobenzene	99+
Toluene	95
Carbon tetrachloride	99
Chloroform	97
Methylene chloride	99
Tetrachloroethylene	93

Biological treatment studies were conducted on a bench scale (Kincannon, 1981) in order to observe the removal of specific compounds by biodegradation versus air stripping. The results indicated that overall removal of compounds to be regulated in the pesticide industry ranged between 93 and 99.9 percent. In the case of 1,2-dichloroethane and 1,2-dichloropropane, this removal is accomplished almost entirely by air stripping, rather than by biodegradation as noted were as follows:

Parameter	Percent Overall Removal	Percent Biodegraded	Percent Air-Stripped
1,2-Dichloropropane	99.4-99.9	0-11.2	88.3-99
Methylene chloride	99.5	94.5	5.0
Benzene	99.9	84.5-85	15.4
1,2-Dichloroethane	98.5	0	97.5-100+
Phenol	99.9+	99.9+	0
Tetrachloroethane	93	0	93
2,4-Dichlorophenol	94	94	0

Preliminary findings of a U.S. EPA program (Feiler, 1980) to study the occurrence and fate of the 129 priority pollutants in 40 POTWs show that, based on the data for the first 20 of the 40 POTWs, 50 percent of secondary treatment plants which utilize the conventional activated sludge process achieve at least 76 percent reduction of total priority pollutant metals, 85 percent reduction of total volatile priority pollutants, and 70 percent reduction of total acid-base-neutral priority pollutants. Median secondary removal rates for specific pollutants to be regulated in the pesticide industry are:

Priority Pollutant	Percent Removal
Zinc	80
Copper	82
Cyanide	54
Toluene	94
Methylene chloride	55
Total phenols	77
BOD	91
COD	83
TSS	92
Tetrachloroethylene	86
Benzene	95
Chloroform	79

Powdered Activated Carbon

Powdered activated carbon (PAC) is used in wastewater facilities to adsorb soluble organic materials, to enhance aerobic biological systems, and to aid in clarification. Powdered carbon can be fed to primary clarifiers, aeration basins, or to separate sludge recirculation clarifiers. The du Pont PACT® process, which incorporates PAC addition to the activated sludge system, is the most widely used form of PAC treatment in wastewater. Spent carbon is removed with the sludge and can then be discarded or regenerated in a furnace or wet air oxidation system.

Powdered carbon adsorption has not been widely used on a full-scale basis in the pesticide industry. Plant 1 designed a PACT® system but switched to granular-activated carbon because it experienced problems with regeneration by wet-air oxidation.

Plant 2 operates three batch activated carbon units for wastewater from three pesticide processes. Separation wash water from one pesticide is initially treated by extraction, gravity separation, and stripping prior to entering the carbon unit. This unit is designed to remove phenol and pesticide.

Prior to the reaction step in a second pesticide process at Plant 2, wastewater passes through solvent extraction, activated carbon, hydrolysis, and ammonia stripping. One to two percent by weight, powdered carbon is mixed with waste from this pesticide in a batch vessel for one hour. The compound 1,2-dichloroethane is felt to be removed by activated carbon; however, no data currently exist from this plant.

Wastewater from the reaction step of a third pesticide at Plant 2 is treated by batch slurry contact activated carbon adsorption. The system is preceded by wastewater extraction, gravity separation, stripping, and chemical oxidation. Carbon treatment was installed to reduce concentrations of pesticide and phenols. Following carbon treatment, wastewater from all three processes is combined with other plant wastes in the general waste treatment plant prior to direct discharge. There is no regeneration of spent carbon.

Advantages of the PACT® process system have been reported by DeJohn (1975) and Frohlich (1976). Among possible benefits are:

1. Improved organic pollutant removal (BOD, COD, and TOC).
2. Protection of biological system against upsets by removal of toxic waste components.
3. Greater proportions of nonbiodegradable materials are removed through direct adsorption.
4. Improved operational stability.
5. Nitrification in single-stage aeration systems.
6. Control of foaming tendencies.
7. Improved oxygen transfer.

Treatability Studies--DeJohn (1975) reported the performance of four full scale activated sludge systems before and after the addition of powdered carbon:

	Parameter	Before	After
Plant 1	BOD Removal	23%	90 to 95%
Plant 2	Effluent COD	1,800 mg/l	350 mg/l
Plant 2	Effluent TOD	100-1,000 mg/l	less than 20 mg/l
Plant 3	TSS & COD	--	40% improvement

Preliminary studies results improvements (Sublette, et al., 1980) on the mechanisms for PAC improvements on the activated sludge processes showed PAC effects are not attributable entirely to physical adsorption, but involve biological enhancement. Studies involving the addition of phenol to reactors showed that microcultures are apparently not affected to such toxins when the toxins are adsorbed by the PAC.

Studies to determine the effect of PAC on biogradation of benzene (Allen and Gloyna, 1980) showed that PAC provided a system of benzene uptake by adsorption and release through desorption that essentially controlled and optimized biological oxidation. Cumulative oxygen uptakes as high as 95 percent of the TOD of the final benzene concentrations were observed.

Berndt and Polkowski (1978) reported on powdered activated carbon/wet air oxidation pilot plant studies where removals of pesticides and PCB's were more than 90 percent higher than removals with the existing full scale activated sludge plant. Similarly, the PAC pilot plant effluent residual concentrations of arsenic, phenol, and total cyanides were shown to be about one-half of the values for the activated sludge system. Effluent concentrations of compounds are listed below:

Parameter	Activated Sludge	PAC/WAO Pilot Plant
TOC mg/l	18.2	8.3
COD mg/l	50	16
Chlorinated pesticides ug/l	0.35	0.017
Organo-sulfur pesticides ug/l	15.0	0
Copper mg/l	0.01	0.008
Zinc mg/l	0.08	0.021
NH_3-N mg/l	12.4	0.17
PCBs ug/l	0.131	0.008

Flynn, et al. (1979) reported on the operational results of a treatment plant receiving organic chemical manufacturing wastes. The plant, using PACT® in conjunction with neutralizers, primary and secondary clarifiers, aerators, and waste sludge thickener with long sludge age, achieves a dissolved organic carbon (DOC) reduction of approximately 80 percent.

Heath (1980) reports on two years operating data for a 40-MGD plant using PACT® process to provide combined secondary/tertiary treatment to industrial wastewater. BOD removals over 96 percent were reported. Other achievements of this system are:

1. The filtration rate of PACT® sludge increases with increasing carbon content.

2. There have been no foaming problems in the PACT® liquid train, even though the wastewater contains surfactants.

Data showed removal of volatile organics to be generally 90 percent with effluent concentration around 10 ug/l. The removal of phenol was reported between 94 and 98 percent and effluent concentration less than 40 ug/l.

Ford and Eckenfelder (1979) report that because many of the organic constituents included in the list of 129 priority pollutants are amenable to carbon adsorption, the attractiveness of the addition of PAC to the activated sludge process for effluent quality control is increasing. Data are presented showing pilot plant performance with PAC addition as follows:

Parameter	Pilot Plant Influent	25 mg/l PAC Addition	50 mg/l PAC Addition
NH_3-N (mg/l)	19	0.4	0.1
Phenolics (mg/l)	3.95	0.006	0.002
Soluble COD (mg/l)	294	50	27

Dual Media Filtration

Dual media filtration involves the use of both sand and anthracite for the removal of solids in pretreatment or tertiary applications.

Full-Scale Systems--Plant 1 employs a settling lagoon followed by multimedia filtration as pretreatment before resin adsorption. Little or no reduction of pesticide and other pollutants was observed across multimedia filtration; however, the following data show the achieved reductions for pesticide and other pollutants across the settling lagoon.

Pollutant	Lagoon Influent (mg/l)	Lagoon Effluent/ Filter Influent (mg/l)	Percent Removal
Pesticide	5.500	0.122	97.8
Copper	0.047	<0.020	57.4
Dibromochloromethane	0.0557	0.005	91.0
Benzene	0.839	<0.010	98.8
Carbon tetrachloride	121.6	8.017	93.4
Chloroform	6.187	2.180	64.8

Plant 2 employs tertiary multimedia filtration to treat wastewaters from pesticide intermediate and active ingredient processes. This filtration system is preceded by two series of activated carbon columns and aerobic biological treatment lagoons.

The following table presents data for some pollutants removed by this series of filters.

Pollutant	Influent (mg/l)	Effluent (mg/l)	Percent Removal
Methylene chloride	0.028	0.025	12.0
1,2-Dichloroethane	0.038	0.036	5.3
Toluene	0.371	<0.010	97.3
Cyanide	0.090	0.069	23.3
Pesticide	<0.002	<0.001	>50.0
Copper	0.135	0.059	56.3
Zinc	0.116	0.075	35.3
BOD	191.0	31	83.8
TSS	96.0	35	63.5

Plant 3 uses a dual media filter for pretreatment before activated carbon. The plant reports that particles less than 10 microns contained in this waste are not retained. The removal of suspended solids achieved by this system is approximately 90 percent with an effluent concentration of 10 mg/l. Data show that pesticide reduction is also accomplished by this treatment. Pesticide concentration is reduced approximately 33 percent, with an average concentration of 40 mg/l in the filter effluent.

Plant 4 operates a multimedia filtration system for pretreatment of two pesticide wastewaters prior to activated carbon adsorption. Following biological treatment, total plant wastewater passes through four sand filters operating in parallel before entry to the carbon system. No data are available to document the removals through the filtration system.

Plant 5 uses multimedia filtration for pesticide wastewater as pretreatment before activated carbon adsorption. Prior to filtration, the flow of approximately 2.08 MGD of pesticide and other process waste enters an equalization and skimming system, then flows to a dissolved air flotation unit, and is neutralized. Although there are no data representing filtration influent, effluent values have been reported by the plant for the following parameters:

Parameter	Value
pH	6
TOC	344 mg/l
TSS	97 mg/l

Contract Hauling

Contract hauling of all pesticide wastewaters has been found to be an economically viable alternative to on-site treatment for the nine manufacturers shown in Table VI-18. The term "contract hauling" refers to the transportation and disposal of wastes by a private company, although some pesticide plants may elect to transport the wastes themselves. In this industry contract hauling is practiced with flows up to 50,000 gpd, although most are in the range from a few gallons up

to 1,000 gpd. Many plants dispose of some, rather than all, wastewaters from pesticide processes. Data on partial disposal were not available for this study.

Evaporation Ponds

Evaporation ponds are open holding facilities which depend on favorable climatic conditions and/or supplementary design factors to effect removal of liquid wastes. Evaporation is generally feasible if evaporation, precipitation, temperature, humidity, and wind velocity combine to cause a net loss of liquid in the pond. If a net loss does not exist then recirculating sprays, roofs, heat, or aeration can be used to offset natural factors. A lagoon lining is recommended to prevent pesticide wastes from entering the groundwater. Solids accumulating over time will eventually require removal by contract hauling, normally after a period of approximately 10 years. Land area requirement is a major factor limiting the amount of flow disposed by this method. The potential for air emissions should be evaluated on a site-by-site basis; however, no adverse effects are known to have been documented.

Full-Scale Systems--Table VI-19 summarizes the use of evaporation ponds in the pesticide manufacturing industry in order to achieve no discharge of process wastewaters. Six plants dispose of volumes from 0.001 to 0.091 MGD. Three plants operate in regions where precipitation exceeds evaporation by up to 12 inches per year; three operate in areas of favorable evaporation conditions.

Ocean Disposal

Plant 1 is the only pesticide manufacturer known to hold a permit to dispose of wastes into the ocean. Table VI-20 shows that up to six pesticides with flows ranging from 5,000 to 12,000 gallons per day are barged without pretreatment. For the past nine years the company has evaluated ten alternatives to ocean disposal. These included evaporation, thermal oxidation, wet-air oxidation, biological treatment, electrochemical oxidation, reverse osmosis, solvent extraction, chemical oxidation, precipitation/coagulation, and irradiation. As a result of these investigations, biological treatment of selected wastes, coupled with evaporation and thermal oxidation of high strength wastes, has been selected as the most cost-effective treatment. The level of pesticides in the barged effluent ranges from 4.0 to 37.0 lbs/1,000 lbs, or approximately 4,000 to 11,000 mg/l.

Deep Well Injection

A deep well disposal system requires a porous, permeable formation of a large area and thickness at sufficient depth to ensure continued, permanent storage. The system must be below the lowest groundwater aquifer, be confined above and below by impermeable zones (aquicludes), and contain no fractures or faults. The wastewater disposed must be chemically compatible with the formation, and provisions must be made for continuous monitoring.

Full-Scale Systems--Deep well injection of pesticide wastewaters is practiced by 17 plants in the industry as shown in Table VI-21. Volumes injected range from 0.00125 to 0.328 MGD. Some plants have no pretreatment, while most have solids removal steps (such as skimming, pressure filtration, or gravity separation) in order to ensure that blockage of the well does not occur. Plant 2 is the only plant known to have installed in-plant controls for the removal of priority pollutants prior to a well. The plant employs steam stripping to reduce chlorobenzenes from 400 to 1 mg/l; it also uses solvent extraction to reduce Pesticide K from 1,000 to 35 mg/l.

DEFINITION OF RECOMMENDED TECHNOLOGIES

Each of the potential technologies described earlier was evaluated in terms of its effectiveness for the removal of individual and groups of priority pollutants. Design criteria were then developed for treatment units recommended.

Treatment Effectiveness for Priority Pollutant Groups

Table VI-22 identifies the treatment technologies considered for application to pesticide chemical wastewaters. The primary unit treatment recommended for each pollutant group is designated with a "1". After pretreatment by the recommended primary unit, it is predicted that pollutant groups can be further removed by treatment units designated by a "2". For example, wastewater containing volatile aromatics is recommended to be pretreated to 1 mg/l by steam stripping (designated as "1"). After steam stripping, and any other pretreatment required, it is recommended that biological oxidation (designated as "2") be utilized to further reduce volatile aromatics and other pollutants. As additional alternatives, dual media filtration and tertiary activated carbon may be applied after biological oxidation. In this example only tertiary activated carbon is assumed to remove volatile aromatics, and is therefore designated as "2".

Design Criteria for Recommended Treatment Units

Each of the recommended treatment units has been designed based on actual systems in place in the pesticides industry. The design criteria utilized have already been demonstrated to achieve the levels specified. The raw waste loads have been derived so that maximum priority pollutant concentrations presented in Section V can be consistently removed. Each unit treatment will be discussed below in conjunction with Figures VI-2 through VI-22, which provide a concise summary of design criteria and flow diagrams.

Pump Station--Pump stations provide a wet well and three individual pumps which will each handle 50 percent of the daily flow during eight hours of service time. The pumping head is assumed to be 20 feet. Pump stations are required to bring the process effluents to the treatment plant, and before any carbon adsorption, resin adsorption, or aeration basins; and to recycle backwash water from dual media filters and carbon

or resin adsorption and overflow from sludge thickener, aerobic digestor, and vacuum filters.

Equalization--Equalization basins of 12-hour detention are provided for raw process wastewater as it leaves the plant, and for 24-hour detention before any biological treatment system. Equalization consists of two basins in parallel, each equipped with a floating aerator providing 75 horsepower per million gallons of volume.

Steam Stripping--A steam stripping system has been provided to remove volatile organics from levels equal to or greater than solubility down to one part per million. The stripped volatile may be recovered if process chemistry considerations allow, or it may be incinerated. The steam stripping system includes an influent storage drum, feed preheater, pump, stripping column, overhead condenser, reflex drum, effluent heat exchanger, and effluent storage drum. The column is designed to have three theoretical and approximately 25 actual trays, assuming a tray efficiency of 12 percent. The reflux is 25 percent of the feed. The theoretical basis for the steam stripping design is presented in Section XVIII, Appendix 7.

Alkaline Chlorination--Alkaline chlorination is provided to treat cyanide to levels of 0.04 ppm from raw waste concentrations greater than 3,000 ppm. It is an established method of cyanide destruction in the metal plating industry. The destruction of cyanide proceeds by the following reactions:

$$Cn^{-} + Cl_2 \rightarrow CnCl + Cl^{-}$$

This reaction is practically instantaneous and independent of pH. The secondary reaction is:

$$CnCl + 2NaOH \rightarrow NaCnO + NaCl + H_2O$$

In the pH range from 8.5 to 11, the reaction takes 5 to 30 minutes to go to completion.

The alkaline chlorination system consists of two batch reactor vessels, feed pumps, recirculation pumps, caustic storage, caustic addition pump, chlorine storage, and a chlorinator. Each reactor vessel is sized for 24 hours detention at flows of 10,000 gallons per day and 12 hours detention at flows of 100,000 gallons per day. Each reactor is provided with 75 horsepower of mixing for each million gallons of volume. The reaction time is assumed to be four hours for the purpose of determining operating costs. The chlorine and caustic usage are assumed to be three parts per part of cyanide.

Metals Separation--Metals separation is accomplished by precipitation of the metal hydroxide. The system has been designed for removal of zinc at 245 mg/l and copper at 4,500 mg/l to an effluent of 0.5 part per million. The optimum pH of operation is 9.0.

The metals separation system consists of influent pumps, two batch mixing tanks, a filter press, an effluent holding tank, caustic storage, caustic addition pump, polymer storage, and a polymer addition pump. Mixing and holding tanks are sized for 24-hour detention at flows of 1,000 gallons per day and 12 hours detention of 30,000 gallons per day. Each tank contains 75 horsepower mixing per million gallons of flow. The filter press operates eight hours per day. The caustic addition rate is 24.5 parts per part of zinc or copper. The polymer addition rate is 20 mg/l.

Hydrolysis--Hydrolysis treatment has been provided as one of several alternatives for pesticide removal. Two flow-through basins have been sized for detention times of 400, 4,000, 10,000, and 24,000 minutes in order to achieve 99.9 percent pesticide removal (the equivalent of 10 half-lives) to 1.0 mg/l or less.

Chemical addition has been provided in order to raise the pH of the wastewater from 7.0 to 11.0, while it has been assumed that steam is available to raise the wastewater temperature from 22°C to 40°C. System components include: caustic storage tank, chemical feeders, mixing tank, basins, temperature control, steam delivery and control, and basin enclosure.

Neutralization--Neutralization has been provided prior to activated carbon and resin adsorption, pesticide removal, and/or prior to biological treatment.

The neutralization basin is sized on the basis of an average detention time of 6 minutes. Either acid or caustic neutralization may be required. For the purpose of cost estimation, caustic neutralization was assumed since it is the most expensive. The size of the caustic soda handling facilities is determined according to a 100 mg/l feed rate. Caustic soda storage is provided based on 30 days' capacity and is fed by positive displacement metering pumps. Seventy horsepower per million gallons is provided for mixing.

Dual Media Pressure Filtration--Dual media pressure filtration has been provided for two purposes. The first is for suspended solids removal prior to activated carbon or resin adsorption applied as a pesticide removal pretreatment. The second purpose is for tertiary polishing after biological oxidation and before tertiary activated carbon treatment.

The filter system design is the same for both applications. Feed pumps load the filters at a rate of 4 gpm/ft^2 against a maximum pumping head of 20 feet. The run length is assumed to be 12 hours, after which time the filters are backwashed for 15 minutes. Backwash water for pretreatment filters is recycled back to a 12-hour equalization basin; backwash water for tertiary filters is recycled to a 24-hour equalization basin. Backwash pumps are sized to accommodate two filters concurrently at a rate of 20 gpm/ft^2 against a maximum head of 30 feet.

Activated Carbon Adsorption--Activated carbon has been provided as a pretreatment and tertiary treatment system. In each case at least two columns in series have been provided. The pretreatment carbon system consists of contact times of 60, 300, 600, and 750 minutes at a loading rate of 0.5 gpm/ft^2. The corresponding carbon usage rate for all detention times is 100 lbs/1,000 gallons of pesticide wastewater. These design characteristics encompass the range found in the industry for removals of 99.9 percent for pesticides while maintaining an effluent level of one part per million or less.

For tertiary treatment a detention time of 30 minutes, a loading rate of 4 gpm/ft^2, and a carbon usage rate of 30 lbs/1,000 gallons has been provided. These design characteristics ensure additional removal for pesticides and other adsorbable compounds such as dienes, nitrosamines, phenols, cyanide, polynuclear aromatics, chlorinated ethanes, metals, BOD, COD, and TSS.

Backwash water for a pretreatment activated carbon system is recycled to a 12-hour equalization basin. For the tertiary activated carbon system, the backwash water is recycled to a 24-hour equalization basin.

Activated Carbon Regeneration--A regeneration facility is provided to include a furnace (feeder, scrubber, and afterburner), spent carbon dewatering tank, slurry pumps, regenerated carbon wash tank, makeup carbon wash tank, and washwater pumps. A 6.5 percent carbon loss during the regeneration step is assumed.

The possibility of carbon replacement rather than regeneration was considered. The sytems involved here are generally too large to make this option economically feasible. The smallest regeneration facility (for tertiary treatment of 0.03 mgd) is at approximately the break-even point for this option.

Resin Adsorption--Resin adsorption has been provided for pretreatment applications. In both cases there are two columns installed in parallel so that each handles half the flow. An additional column remains as a spare. The columns have been sized for a 15-minute contact time and a loading rate of 4 gpm/ft^2. The columns are regenerated daily. The columns are expected to remove phenols and pesticides down to an effluent level of 1 part per million or less.

Backwash water for the resin adsorption pretreatment system is recycled to a 12-hour equalization basin. The backwash water for resin adsorption tertiary treatment is recycled to a 24-hour equalization basin.

Resin Regeneration--A regeneration facility has been provided to include methanol storage, methanol pumps, batch distillation column, overhead condenser and reflux drum. Regeneration consists of solvent extraction with two bed volumes of methanol followed by batch distillation to separate the solvent from adsorbed organics. The methanol loading rate is 0.3 gpm/ft^2. The distillation column has ten actual plates and a reflux ratio of three to one.

Nutrient Addition--Nutrient addition is provided prior to aeration. Phosphoric acid addition and anhydrous ammonia addition are included. Addition rates are set to maintain a BOD/P/N ratio of 100/5/1.

Aeration Basins--As part of an activated sludge system a minimum of two aeration basins in parallel are provided. Each basin has a detention time of three days and a mixed liquor suspended solids concentration of 3,000 mg/l. Mechanical surface aerators are provided in the aeration basin with 100 horsepower per million gallons treated. Aerators were selected on the basis of 1.5 lbs of oxygen per horsepower-hour.

Clarification--As part of an activated sludge system a minimum of two clarifiers in parallel have been provided. The clarifiers are assumed to be circular concrete basins with a depth of 12 feet. They are sized on the basis of an overflow rate of 400 gpd/ft^2. Allowances are made for a sludge return capacity of 200 percent.

Sludge Thickener--The sludge thickener is designed on the basis of a solids loading of 10 $lb/ft^2/day$. A solids concentration of 2 percent is assumed for sludge leaving the thickener. Water leaving the thickener is recycled to a 24-hour equalization basin.

Aerobic Digestion--The size of the aerobic digester is based on a hydraulic detention time of 20 days. The size of the aerators/mixers is based on 150 horsepower per million gallons of digester volume. A solids production of 0.6 lb VSS/lb BOD removed and a VSS reduction of 50 percent were assumed. A solids concentration of 3.5 percent was assumed for sludge leaving the digester. Water leaving the digestor is recycled to a 24-hour equalization basin.

Vacuum Filtration--The size of the vacuum filters is based on a solids loading of 4 $lb/ft^2/hr$ with effluent solids at 15 percent. Average running times of 12 hours are assumed. Chemical addition (ferric chloride) at a rate of 7 percent by weight of dry solids is provided. Filtrate is recycled to a 24-hour equalization basin.

Contract Hauling--Contract hauling of activated and metals sludge is provided to both hazardous and nonhazardous landfills.

Incineration--A liquid-vapor incineration system has been provided to handle concentrated organic process wastes, condensed organics from steam stripping systems which cannot be reused, reactor vent streams, and other refractory streams. The volume to be incinerated is assumed at 1 percent of the total wastewater treatment system flow.

The design of the incinerator is based on flow volume and waste type. Cost curves have been developed for five types of wastes which might be encountered in the industry:

1. Hydrocarbons,

2. Chlorinated aliphatics,

3. Chlorinated aromatics,

4. Aqueous oily wastes, and

5. Aqueous ammonia wastes.

The incineration system includes influent storage and pump, fuel storage and pump, fan, incinerator, venturi scrubber, final scrubber, scrubber water holding tank and pump, and stack. For chlorinated organics incineration, caustic or lime storage and feeders, a mixing tank, and mixer are provided to neutralize the HCl formed. Caustic is used for small flows and lime is used for large flows where the large capital investment would be offset by the lower price of lime. Steam recovery has been designed and included in cost calculations.

Evaporation Ponds--Two alternatives for evaporation ponds were designed. A solar evaporation system was designed for net evaporation rates of 5, 10, 20, and 30 inches per year. Based on these rates the surface area required for the pond was calculated assuming that there was a period of four months when precipitation exceeded evaporation by 30 inches per year. A 4-foot deep lined pond was provided using the assumptions itemized above.

A spray evaporation pond was designed for situations where the net evaporation rate was not sufficient. This system consists of a lined pond with recirculation pumps, pipes, and nozzles installed at the height of 10 feet in order to assist natural climatic conditions. An equation developed by Reynolds and Shack (1976) was used to approximate evaporation as shown below:

$$E = 1260.5\ Whp \left[1-e^{-\left(\frac{K_y'\ L + C_w\ WL}{5280\ Whp}\right)} \right] \left[\frac{(1-H_r)P_s}{P_a} \right] RLn$$

In the previous equation the following definitions apply:

1. E = Evaporation (ft^3 per month)

2. W = Wind velocity (mph)

3. h = height of spray above pond surface (feet)

4. p = air density = $(39.66\ P_a) \div (460 + T_a)$

   Where: P_a = atmospheric pressure (atmosphere)
   T_a = atmospheric temperature (°F)

5. K_y' = spray mass transfer coefficient

6. L = pond length (ft)

7. C_w = surface mass transfer coefficient

8. H_r = relative humidity (as a decimal)

9. P_s = saturation vapor pressure (atmosphere)

10. R = ratio of width to length

11. n = days per month

Given the evaporation established above, the amount of rainfall and the amount of flow into the pond will determine pond depth and land requirements. It was assumed that annual rainfall was equal to 40 inches per year, and that for determining pond depth there was at least a 10-week period during the year when there was rainfall but no evaporation. The resulting pond design was 4 feet deep including 2 feet of freeboard, with a berm slope of 3:1. The top of the berm was assumed to be 2 feet wide and 2 feet from the fenced property line.

Table VI-1. Principal Types of Wastewater Treatment/Disposal

Type of Treatment/Disposal	Number of Plants*
Biological Oxidation	32
Activated Carbon	17
Deep Well Injection	17
Incineration	13
Chemical Oxidation	9
Contract Hauling of All Wastewater	9
Hydrolysis	8
Steam Stripping	8
Multimedia Filtration	7
Evaporation	6
Resin Adsorption	4
Metals Separation	3

* = There are a total of 117 plants in industry; however, many have more than one means of treatment/disposal.

Table VI-2. Plants Using Stripping for Pesticide Wastewaters

Plant Code	Product/ Process Code	Type Stripper	Flow (MGD)	Stripped Material
1	A	Vacuum	NA	Isobutyl alcohol
	B	Steam	0.0165	Methylene chloride
	C	Steam	NA	Xylene
	D	Steam	NA	Xylene
2	E	Steam	0.01	Chloroform, hexane
	F	Steam	0.05	Chloroform, hexane
	G	Steam	0.06	Chloroform, hexane
3	H	Steam	NA	Ethylene dichloride
	I	Steam	NA	NA
	J	Steam	NA	Methanol
	K	Steam	NA	Toluene
	L	Steam	NA	Toluene
	M	Steam	NA	Methanol
	N	Steam	NA	NA
	O	Steam	NA	NA
	P	Steam	NA	Toluene
	Q	Steam	NA	NA
4	R	Steam	0.072	Ammonia, ethylamine
5	S	Steam	0.09	1,2-dichloroethane
6	T	Steam	0.0326	Ammonia
7	U	Steam	0.048	Methylene chloride
8	V	Steam & Vacuum	0.09	Toluene
	W	Steam & Vacuum	0.06	Toluene
	X	Steam & Vacuum	0.04	Toluene

NA = Not available.

Table VI-3. Steam Stripping Operating Data

VOLATILE AROMATICS

Benzene				Toluene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.07	<0.04	42.8	1	<0.070	<0.041	42.1
6	<0.050	<0.050	NA	6	<0.20	<0.20	NA
6	ND	ND	NA	6	ND	ND	NA
8	<0.299°	<0.299°	NA	8	>99.5	29.1	>70.7
				8	686	33.8	95.1
				8	1,570	86.5	94.5
				8	528	24.2	95.4

Chlorobenzene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	ND	ND	NA

HALOMETHANES

Methylene chloride				Chloroform			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<159	<0.01°	99.9	1	<0.0623	<0.0010°	98.4
6	0.005	0.02	+	2	70.0*	<5.0*	>92.9
6	<0.798	<0.645	19.2	6	<0.30	<0.733	+

Carbon tetrachloride			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.0010	<0.0010	NA

Footnotes at end of table.

Table VI-3. Steam Stripping Operating Data (Continued, Page 2 of 2)

CHLORINATED ETHANES AND ETHYLENES

	Trichloroethylene		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.070	<0.04	42.9
6	NA	0.01	NA

AMMONIA

	Ammonia		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	>50.0	5.00	>90.0
6	2540	95	96.3
6	7890	98.0	98.8

NA = Not available.
ND = Not detected.
+ = Concentration increased.
° = Analysis not conducted per protocol.
* = Data from comingled waste stream.

Table VI-4. Plants Using Chemical Oxidation for Pesticide Wastewaters

Plant Code	Pesticide Code	Pesticide Volume Disposed (MGD)	pH	Chemical Oxidant
1	A	NA	NA	Hydrogen peroxide
	B	0.029	NA	Sodium hypochlorite
	C	NA	NA	Hydrogen peroxide
	D	NA	NA	Hydrogen peroxide
	E	NA	NA	Hydrogen peroxide
2	F	0.0634	13-14	Formaldehyde
3	G	0.10	7-11	Chlorine
	H	0.02	7-11	Chlorine
4	I	0.07	1	Hydrogen peroxide
5	J	0.0005	8	Hydrogen peroxide
	K	0.0015	8	Hydrogen peroxide
6	L	0.02	10-12	Chlorine
	M	0.015	10-12	Chlorine
7	N	0.0003	7-12	Sodium hypochlorite
8	O	0.01	NA	NA
	P	0.01	NA	NA
	Q	0.01	NA	NA
9	R	0.0026	NA	Cobaltous chloride

NA = Not available.

Table VI-5. Chemical Oxidation Operating Data

CYANIDE

Cyanide			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	5503°	19.7	99.6

PHENOLS

Phenol			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
5	1100*	2.03*	99.8

MANUFACTURED PESTICIDES

Pesticides				
Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
F	2	83.2	<0.145	>99.8
S	3	1.33	<0.01	>99.3
S	3	3.46	1.26	63.6
T	3	2.03	<0.01	>99.5
G	3	2.40	0.229	90.5
V	3	2.57	1.19	54.4
H	3	398	0.187	99.9
H	3	19.2	3.19	83.4
U	3	0.013	0.299	+
I	4	NA	NA	98.9†
K	5	NA	0.023*	NA
J	5	NA	0.023*	NA

VOLATILE AROMATICS

Chlorobenzene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	ND	ND	NA

Toluene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	<0.01	<0.01	NA

NA = Not available.
ND = Not detected.
° = Analysis not conducted per protocol.
* = Data from comingled waste stream.
† = Pilot plant data.
+ = Concentration increased.

Table VI-5. Chemical Oxidation Operating Data (Continued, Page 2 of 2)

HALOMETHANES

Carbon tetrachloride				Methylene chloride			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	Trace	0.014°	NA	3	ND	ND	NA

Chloroform			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.0367	1.50	+
3	0.170°	1.90°	+

NA = Not available.
ND = Not detected.
\+ = Concentration increased.
° = Analysis not conducted per protocol.

Table VI-6. Plants Using Metals Separation for Pesticide Wastewaters

Plant Code	Pesticide Code	Flow (MGD)	Type of System	Effluent Concentration (mg/l)
1	A	0.06	Hydrogen Sulfide Precipitation	2.2-2.8 (Cu)
2	B	NA	Sodium Sulfide Precipitation	NA
3	C* D*	0.35	Ferric Sulfate, Lime Precipitation	0.2 (As) 0.11 (Zn)

NA = Not available.
* = Previously manufactured metallo-organics.
As = Arsenic
Cu = Copper
Zn = Zinc

Table VI-7. Plants Using Granular Activated Carbon for Pesticide Wastewaters

Plant Code	Pesticide Code	Volume Treated (MGD)	pH	Calculated Empty Bed Contact Time	Carbon Usage (lb/1000 gal)	Reactivation Method
1	A	0.0451	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	B	0.0165	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	C	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	D	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	E	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	F	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	G	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	H	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
	I	NA	1.0-1.5	320 Min.	26.0	Off-site/Thermal
2	J	0.00453	0.5-4.0	588 Min.	81.5	Off-site/Thermal
	K	0.009	0.5-4.0	588 Min.	81.5	Off-site/Thermal
3*	L	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
	M	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
	N†	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
	O	0.40°	7.0	19.1 Min.	3.9	Off-site/Thermal
4	P	0.015	NA	NA	NA	NA
	Q	0.012	NA	NA	NA	NA
5	R	1.26°	6-12	18-52 Min.	20.0-33.5	On-site/infrared furnace
	S	1.26°	6-12	18-52 Min.	20.0-33.5	On-site/infrared furnace
	T	1.26°	6-12	18-52 Min.	20.0-33.5	On-site/infrared furnace
6	U	0.050-0.075	8.5-9.5 (A)	1000 Min. (A)	136 (A)	Off-site/Thermal
	V	NA	8.5-9.5 (A)	1000 Min. (A)	136 (A)	Off-site/Thermal
	W	NA	8.5-9.5 (A)	1000 Min. (A)	136 (A)	Off-site/Thermal
	Pesticide Intermediate	0.025-0.030	1.5 (N)	571 Min. (N)	NA (N)	Off-site/Thermal

Footnotes at end of table.

Table VI-7. Plants Using Granular Activated Carbon for Pesticide Wastewaters (Continued, Page 2 of 2)

Plant Code	Pesticide Code	Volume Treated (MGD)	pH	Calculated Empty Bed Contact Time	Carbon Usage (lb/1000 gal)	Reactivation Method
7	X	0.046	6-8	480 Min.	95.0	Off-site/Thermal
	Y	0.047	6-8	480 Min.	95.0	Off-site/Thermal
8	Z	0.16	8-12	100 Min.	2.89	Off-site/Thermal
9	AA	0.07	NA	NA	NA	NA
10	BB	0.02	5-9	250 Min.	69.3	Off-site/Thermal
11	CC	0.001	NA	NA	NA	NA
	DD	0.0005	NA	NA	NA	NA
12	EE	0.0028	NA	NA	NA	On-site/Thermal
13	FF	0.010	6	109 Min.	0.92	On-site/Thermal
14	GG	0.00133	>1	35 Min.	NA	On-site/Isopropanol
15	HH	0.0275	2.0	420 Min.	451.0	Off-site/Thermal
	HH	0.0002	2.0	420 Min.	451.0	Off-site/Thermal
16	II	0.12	11.6-12.5	91.5 Min.	71.6	Off-site/Thermal
	II	0.18	11.6-12.5	60.8 Min.	47.7	Off-site/Thermal
17	JJ	0.0005	4.0-10.6	60 Min.	2.0	Off-site/Thermal
	KK	0.0004	4.0-10.6	60 Min.	2.0	Off-site/Thermal

° = Combined pesticide flow.
* = Utilized as tertiary treatment.
† = Production discontinued.
NA = Not available.
(A) = Amination.
(N) = Nitration.

Table VI-8. Granular Activated Carbon Operating Data

MANUFACTURED PESTICIDES

Pesticides

Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
B	1	7.83	<0.0084	>99.9
B	1	<4.63	<0.0147	99.7
A	1	83.0	0.0428	99.9
A	1	82.5	<0.0359	>99.9
C	1	<0.01	<0.01	NA
K	2	0.465	<0.001	>99.8
K	2	15.5	0.0182	99.9
O	3	NA	0.0055	NA
O	3	0.065†	0.005	92.3
M	3	10.4	<0.92	>91.2
M	3	10.9	<0.342	>96.9
L	3	40.7	<5.84	>85.7
L	3	18.1	0.680	96.2
P	4	9300	1.7	99.9
Q	4	15	0.01	99.9
R,S,T	5	133*	4.7*	96.5
R,S,T	5	45.7*	12.4*	72.9
U	6	184	2.82	98.5
U	6	14.6	0.0713	99.5
U	6	3.37	0.004	99.8
Y	7	7.57	>0.01	<99.9
X	7	218	1.26	99.4
Z	8	31.3	<10.0	>68.0
Z	8	41.8	15.2	63.6
BB	10	160.0	<0.025	>99.9
BB	10	477	3.37	99.3
FF	13	NA	0.00602	NA
GG	14	17.2	11.0	36.0
HH	15	7.75	2.45	68.4
HH	15	3460	5.71	99.8
HH	15	320	4.32	98.6
HH	15	1780	1.85	99.9
HH	15	4.2	1.4	66.7
II	16	<1420	<314	77.9

* = Data from comingled waste stream.
† = Analysis not conducted per protocol.
NA = Not available.

Table VI-8. Granulated Activated Carbon Operating Data
(Continued, Page 2 of 6)

PHENOLS

Phenol				2-Chlorophenol			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	44.1*	0.197*	99.6	1	<5.09*	<0.0233*	99.5
1	<1.82*	<0.081*	95.5	1	11.2*	<0.010*	>99.9
4	0.92	<0.01	>98.9	8	ND	ND	NA
4	280	0.029	99.9	15	0.040	ND	NA
6	<0.015†	<0.01	33.3				
8	ND	ND	NA				

2,4-Dichlorophenol				2,4,6-Trichlorophenol			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	92.2*	<0.0591*	>99.9	1	<3.69*	<0.0493*	98.7
1	NA	0.482°	NA	1	2.20*	<0.010*	>99.5
1	NA	0.498°	NA	4	8700	0.068	99.9
1	53.7*	<0.022*	>99.9	8	ND	ND	NA
4	42,000	0.82	99.9				

Pentachlorophenol				Total phenol			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
				1	<145*	<0.329*	99.8
2	<1.0	<0.10†	90.0	1	<79.6*	<0.143*	99.8
6	<0.01	<0.01†	NA	2	<0.0056	<0.001	82.1
				3	0.187	0.118	36.9

NA = Not available.
ND = Not detected.
† = Analysis not conducted per protocol.
° = Reported as total phenol with 2,4-dichlorophenol principal constituent.
* = Data from comingled waste stream.

Table VI-8. Granulated Activated Carbon Operating Data
(Continued, Page 3 of 6)

NITROSAMINES

N-nitrosodi-n-propylamine			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	0.069	0.0067	90.3
6	0.123	0.0276	77.6
6	1.96	0.0041	99.8
8	ND	ND	NA

VOLATILE AROMATICS

Benzene				Toluene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.01*	<0.01*	NA	1	0.0162*	0.0194*	+
4	NA	<0.012	NA	4	NA	<0.006	NA
4	0.073	<0.01	>86.3	4	0.03	<0.01	>66.7
7	ND*	NA	NA	5	5.80*	<0.1*	>98.3
15	<0.050	<0.050	NA	5	1.08	NA	NA
15	0.02	ND	NA	5	2.69*	NA	NA
				7	0.137*	<0.007*	>94.9
				15	ND	ND	NA
				15	<0.20°	<0.20	NA

NA = Not available.
ND = Not detected.
+ = Concentration increased.
* = Data from comingled waste stream.
° = Analysis not conducted per protocol.

Table VI-8. Granulated Activated Carbon Operating Data
(Continued, Page 4 of 6)

VOLATILE AROMATICS (Continued)

Plant	Chlorobenzene Influent mg/l	Chlorobenzene Effluent mg/l	Chlorobenzene Percent Removal	Plant	Hexachlorobenzene Influent mg/l	Hexachlorobenzene Effluent mg/l	Hexachlorobenzene Percent Removal
2	<0.01	<0.01	NA	2	<0.008	<0.001	87.5

Plant	Dichlorobenzene† Influent mg/l	Dichlorobenzene† Effluent mg/l	Dichlorobenzene† Percent Removal
2	<0.108	<0.0167	84.5

HALOMETHANES

Plant	Methylene chloride Influent mg/l	Methylene chloride Effluent mg/l	Methylene chloride Percent Removal	Plant	Chloroform Influent mg/l	Chloroform Effluent mg/l	Chloroform Percent Removal
1	3.54*	<3.07*	>13.3	1	<0.0689*	<0.0119*	82.7
1	1.70*	1.49*	12.5	1	0.0189*	0.0231*	+
4	0.88	<0.01	>98.9	3	0.623	0.210	66.3
4	NA	1.43	NA	4	<0.09	<0.01	88.9
6	0.326	<0.010	>96.9	4	NA	<0.0233	NA
8	ND	ND	NA	10	<0.30°	<0.30°	NA
10	12.7°	<0.10°	>99.2				
15	<0.10	<0.798	+				

NA = Not available.
ND = Not detected.
† = Combined dichlorobenzenes: 1,2; 1,3; 1,4.
° = Analysis not conducted per protocol.
* = Data from comingled waste stream.
+ = Concentration increased.

Table VI-8. Granulated Activated Carbon Operating Data
(Continued, Page 5 of 6)

HALOMETHANES (Continued)

	Carbon tetrachloride		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	<0.150*	<0.0261*	82.6
1	<0.0010*	<0.0010*	NA
3	10.5*	2.32*	77.9
4	NA	<0.02	NA
4	<0.91	<0.01	98.9
5	0.39	NA	NA
5	0.168*	NA	NA
5	<0.16*	<0.1*	37.5

CHLORINATED ETHANES AND ETHYLENES

	1,2-Dichloroethane		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	<0.022	<0.012	45.5
4	NA	<0.01	NA

NA = Not available.
ND = Not detected.
* = Data from comingled waste stream.

Table VI-8. Granulated Activated Carbon Operating Data
(Continued, Page 6 of 6)

TRADITIONAL PARAMETERS

BOD				COD			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	5690*	4136*	27.3	1	8000*	2580*	67.7
3	137.0*	319.0*	+	2	1500	204	86.4
5	ND*	<20.0*	+	3	895.0*	819.0*	8.49
5	78.8	NA	NA	5	353*	<285*	>19.3
6	NA	316	NA	5	890	NA	NA
7	NA	889*	NA	5	468*	NA	NA
10	<103	<1.92	98.2	6	5120	2880	43.7
14	45200	37400	17.3	7	4750*	808*	83.0
15	3331	2397	28.0	10	4880	31.2	99.4
				14	148000	109000	26.3
				15	28021	5340	80.9
				15	75500	60000	20.5

TSS				TOC			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	56.6*	185*	+	2	430	40.3	90.6
2	235	150	36.2	5	585*	81.0*	86.2
3	35.0*	35.0*	0.0	5	178*	NA	NA
5	411*	25.7*	93.7	7	1650*	153*	90.7
5	178	NA	NA	10	2170	15.4	99.3
5	253*	NA	NA	13	<344*	<245*	28.8
6	NA	34.0	NA	14	79800	66700	16.4
7	68.6*	46.6*	32.1	15	28489	6538	77.0
8	77.5	32.3	58.3	15	19500	3300	83.1
10	87.7	<5.00	>94.3	16	523	165	68.4
13	<97.0*	<117*	+				
14	1460	2600	+				
15	4094	204	95.0				
15	3000	2000	33.3				

NA = Not available.
+ = Concentration increased.
* = Data from comingled waste stream.

Table VI-9. Plants Using Resin Adsorption for Pesticide Wastewaters

Plant Code	Pesticide Code	Volume Disposed (MGD)	Flow Rate (GPM/Ft^2)	pH	Empty Bed Contact Time	Regeneration Solvent/Disposal
1	A	0.15	4.0	6-8	7.5 Min.	Methanol/Boiler fuel
2	B*	0.10	1.0	4.5	30 Min.	Sodium hydroxide/Recycle
3	C	0.14	3.5	3-4	15 Min.	Isopropanol/Boiler fuel
	D	0.04	3.5	3-4	15 Min.	Isopropanol/Boiler fuel
4	E	0.09	3.6	1.5	15 Min.	Methanol/Distilled-Reused
	F	0.06	3.6	1.5	15 Min.	Methanol/Distilled-Reused
	G	0.04	3.6	1.5	15 Min.	Methanol/Distilled-Reused

* = Production discontinued.

Table VI-10. Resin Adsorption Operating Data

MANUFACTURED PESTICIDES

Pesticides

Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
A	1	0.154	0.00067	99.6
A	1	0.142	0.00123	99.1
D	3	0.095	0.038	60.0
D	3	0.320	0.010	96.9
C	3	0.518	0.539	+
C	3	<0.51	<0.015	97.1
E	4	129	24.0	87.5*
E	4	612	18.6	97.0
E	4	<331	<19.5	94.1
E	4	260	61.1	76.5
E	4	248	26.7	89.2
F	4	<152	<18.3	88.0
G	4	71.1	<9.24	>87.0

PHENOLS

2-Chlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.152	<0.01	93.4
4	0.162	<0.0314	>80.6
4	<0.718	<0.069	90.4

2,4-Dichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	5.76	0.523	93.9*
4	<10.5	<4.32	58.9
4	3.15	<0.462	>85.3
4	5.46	<1.53	>72.0

2,4,6-Trichlorophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.348	<0.163	68.8*
4	0.378	<0.0892	>76.4
4	<0.544	<0.219	59.7

4-Nitrophenol

Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	1000†	1.00†	99.9

NA = Not available.
ND = Not detected.
* = Removal based on pollutant mass balance, not concentration.
† = Pilot scale data.
†† = Reported as total phenol with 2,4-dichlorophenol as principal constituent.
+ = Concentration increased.

Table VI-10. Resin Adsorption Operating Data (Continued, Page 2 of 4)

PHENOLS (Continued)

Plant	Phenol Influent mg/l	Phenol Effluent mg/l	Phenol Percent Removal
4	3.82	1.15	69.8*
4	0.955	0.518	45.8

DIENES

Plant	Hexachlorocyclopentadiene Influent mg/l	Hexachlorocyclopentadiene Effluent mg/l	Hexachlorocyclopentadiene Percent Removal	Plant	Hexachlorobutadiene Influent mg/l	Hexachlorobutadiene Effluent mg/l	Hexachlorobutadiene Percent Removal
3	0.827*	0.123*	85.1	3	0.210*	0.01*	91.1**
3	0.435*	0.034*	92.2				

VOLATILE AROMATICS

Plant	Benzene Influent mg/l	Benzene Effluent mg/l	Benzene Percent Removal	Plant	Toluene Influent mg/l	Toluene Effluent mg/l	Toluene Percent Removal
1	<0.053	<0.032	34.5**	3	2.10*	0.742*	64.7
4	<0.298	NA	NA	4	16.8	8.76	65.2**
				4	<171	<79.6	53.5
				4	20.8	19.8	63.1
				4	25.2	<16.4	>34.9
				4	82.9	NA	NA

NA = Not available.
* = Data from comingled waste stream.
** = Removal based on pollutant mass balance, not concentration.

Table VI-10. Resin Adsorption Operating Data (Continued, Page 3 of 4)

VOLATILE AROMATICS (Continued)

Chlorobenzene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	0.577	0.151	39.2**

HALOMETHANES

Chloroform				Chlorodibromomethane			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	6.19	2.51	59.4	1	<0.0063	0.005	<13.8**
3	0.382*	0.339*	11.2				

Carbon tetrachloride			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	8.07	5.49	28.4**
3	67.9*	44.5*	34.5

POLYNUCLEAR AROMATIC HYDROCARBONS

Naphthalene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	1.06*	0.297*	72.0

* = Data from comingled waste stream.
** = Removal based on pollutant mass balance, not concentration.

Table VI-10. Resin Adsorption Operating Data (Continued, Page 4 of 4)

CHLORINATED ETHANES AND ETHYLENES

	Tetrachloroethylene		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	0.054	0.018	55.3**
3	0.467*	0.199*	57.4

TRADITIONAL PARAMETERS

	BOD				COD		
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	55.0	55.0	0.0	1	674	576	17.9**
3	331*	278*	16.0	3	675*	545*	19.3
4	1906	2104	+				

	TSS				TOC		
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	23.0	19.0	25.0**	1	62.0	59.0	3.85**
3	208*	81.3*	60.9	3	342*	301*	12.0
				4	2670*	2590	3.0

* = Data from comingled waste stream.
** = Removal based on pollutant mass balance, not concentration.
\+ = Concentration increased.

Table VI-11. Plants Using Hydrolysis for Pesticide Wastewaters

Plant Code	Pesticide Code	Pesticide Volume Disposed (MGD)	pH	Detention Time	Temperature	Type System
1	A	0.00451	>9.0	>108 Hrs.	Ambient	Batch
2	B	0.056	<1.0	264 Hrs.	Ambient	Continuous
3	C	0.025	12.7	3 Hrs.	46.1°C	Batch
4	D	NA	<10	120 Hrs.	NA	Continuous
	E	NA	<10	120 Hrs.	NA	Continuous
5	F	NA	11-12	Variable	30°-40°C	Continuous
	G	NA	8-12	Variable	65°-100°C	Batch
	H	NA	8-12	Variable	65°-100°C	Batch
	I	NA	12+	Variable	100°C	Continuous
	J	NA	8-12	Variable	65°-100°C	Batch
	K	NA	12+	Variable	100°C	Continuous
	L	NA	12+	Variable	100°C	Continuous
	M	NA	13+	Variable	30°-35°C	Continuous
	N	NA	8-12	Variable	65°-100°C	Batch
	O	NA	12+	Variable	100°C	Continuous
	P	NA	12+	Variable	100°C	Continuous
6	Q	0.0634	NA	NA	NA	Continuous
	R	0.006	12-14	12 Hrs.	43.3°C	Continuous
	S	0.015	12-14	12 Hrs.	43.3°C	Continuous
	T	0.025	12-14	12 Hrs.	43.3°C	Continuous
	U	0.007	12-14	12 Hrs.	43.3°C	Continuous
	V	0.013	12-14	12 Hrs.	43.3°C	Continuous
7	W,X	0.02-0.015	10-12	80 Min.	104°C	Continuous
	W,X	0.02-0.015	4-6	50-60 Min.	104°C	Continuous
8	Y	0.010	9	19 Hrs.	75°C	Continuous

NA = Not available.

Table VI-12. Hydrolysis Operating Data

MANUFACTURED PESTICIDES

Pesticides

Pesticide Code	Plant	Influent mg/l	Effluent mg/l	Percent Removal
A	1	3300	5.49	99.8
B	2	57	0.049	99.9
C	3	27.0	0.56	97.9
C	3	26.8	1.7	93.7
E	4	12.2**	<0.01**	>99.9
D	4	12.2**	<0.01**	>99.9
G	5	20	<1.0*	>95.0
F	5	50	<1.0*	>98.0
J	5	50	<1.0*	>98.0
N	5	60	<1.0*	>98.3
L	5	60	<1.0*	>98.3
H	5	60	<1.0*	>98.3
K	5	104	4.0	96.1
P	5	150	<2.0*	>98.7
O	5	200	1.0*	99.5
I	5	300	<1.0*	>99.7
M	5	1000	<2.0*	>99.8
Q	6	NA	NA	>95.0†
V	6	NA	<0.01	NA
U	6	NA	<0.1	NA
T	6	NA	<0.1	NA
S	6	NA	<0.01	NA
R	6	NA	<0.5	NA
X	7	NA	ND†	NA
W	7	55	<0.001	>99.9
Y	8	720	90.8	87.4

NA = Not analyzed.
ND = Not detected.
* = Sampling has demonstrated that cited effluent removal is achievable; average varies based on pH, temperature, and detention time.
† = Design basis.
** = Hydrolysis and biological oxidation treatment combined.

Table VI-13. Plant 10 Hydrolysis Data for STCT Pesticides

Pesticide Code	pH	Temp (°C)	Half-Life (Hours)
Z	10	20	Less than one hour
AA and BB	3	20	1.0
		35	0.45
		50	0.27
	6	20	2.7
		35	2.7
		50	5.0
	9	20	12.9
		35	8.0
		50	6.0
CC	3	20	Greater than 40 days
	6	20	Greater than 40 days
	9	20	72
DD	4	30	120
	4	60	50
	8	30	Less than 24 hours
	8	60	Less than 24 hours

Table VI-14. Hydrolysis Data--Triazine Pesticides

Pesticide	pH	Temp (°C)	Half-Life (Hours)	Reference
Atrazine	13	25	48	Armstrong, et al., 1967
	0.5	40	3.3	Lowenbach, 1977
	1	25	80	Little, et al., 1980
	1	80	4.7	Little, et al., 1980
	3	25	331	Little, et al., 1980
	12	25	295	Little, et al., 1980
	14	25	4.5	Little, et al., 1980
	16	80	0.27	Little, et al., 1980
Cyanazine	1.55	25	30	Brown, et al., 1972
Prometryn	1.0	25	22	Kearney, et al., 1969
Ametryne	11	41	133	LAI, 1977
	1	41	22	LAI, 1977
	0.5	41	10	LAI, 1977
Metribuzin	11	23	270	LAI, 1977
	11	41	236	LAI, 1977
	1	23	19	LAI, 1977
	1	41	9	LAI, 1977
Cyprazine	1	23	43	LAI, 1977
	1	41	8	LAI, 1977
Simazine	1	23	33	LAI, 1977
	1	41	8	LAI, 1977
Atratone	11	23	420	LAI, 1977
	11	41	290	LAI, 1977
	1	23	176	LAI, 1977
	1	41	48	LAI, 1977

Table VI-15. Plants Using Incineration* for Pesticide Wastewaters

Plant Code	Pesticide Code	Pesticide Volume Incinerated (MGD)	Incinerator Capacity (BTU/HR)	Percent Devoted to Pesticides
1	A	0.000234	$30\text{-}35 \times 10^6$	5.7
2	B	NA	36.0×10^6	60
	C	NA	36.0×10^6	60
	D	NA	36.0×10^6	60
	E	NA	36.0×10^6	60
	F	NA	36.0×10^6	60
	G	NA	36.0×10^6	60
3	H	NA	8.7×10^6	100
	I	NA	8.7×10^6	100
	J	NA	8.7×10^6	100
	K	NA	20.0×10^6	100
4	L	NA	35.0×10^6 and 70.0×10^6	NA
	M	NA	35.0×10^6 and 70.0×10^6	NA
	N	0.0028	35.0×10^6 and 70.0×10^6	NA
	O	0.0013	35.0×10^6 and 70.0×10^6	0.55
	P	0.0033	35.0×10^6 and 70.0×10^6	4.68
	Q	NA	35.0×10^6 and 70.0×10^6	NA
5	R	NA	3000 BTU/lb feed	100
	S	0.002	3000 BTU/lb feed	100
	T	0.05	3000 BTU/lb feed	100
	U	0.0005	3000 BTU/lb feed	100
	V	NA	3000 BTU/lb feed	100
6	W	0.002	10×10^6	NA

Footnotes at end of table.

Table VI-15. Plants Using Incineration* for Pesticide Wastewaters (Continued, Page 2 of 2)

Plant Code	Pesticide Code	Pesticide Volume Incinerated (MGD)	Incinerator Capacity (BTU/HR)	Percent Devoted to Pesticides
7	X	NA	20.0×10^6	NA
	Y	NA	9.0×10^6 and 12.0×10^6	NA
	Z	NA	9.0×10^6 and 12.0×10^6	NA
	AA	NA	9.0×10^6 and 12.0×10^6	NA
	BB	NA	9.0×10^6 and 12.0×10^6	NA
	X	NA	9.0×10^6 and 12.0×10^6	NA
	CC	NA	9.0×10^6 and 12.0×10^6	NA
	DD	NA	9.0×10^6 and 12.0×10^6	NA
	EE	NA	9.0×10^6 and 12.0×10^6	NA
8	FF	0.0010	5.0×10^6	NA
9	GG	0.039	76.7×10^6	100
	HH	0.001	76.7×10^6	100
10	II	0.024	48.0×10^6	100
11	JJ	0.0029	12.0×10^6	100
12	KK	NA	NA	NA
13	LL	0.0000111	14.0×10^6	NA
	MM	0.000105	10.0×10^6	NA
	LL	0.0000076	10.0×10^6	NA
14	NN	0.0115	9.5×10^6	100

NA = Not available.
* = Refers to the disposal of gaseous and organic liquid streams by specific incineration facilities, not as a supplemental fuel in boilers.

Table VI-16. Plants Using Biological Treatment for Pesticide Wastewaters

Plant Code	Products Manufactured	Type of System	Detention Time (Hours)	Activated Sludge MLSS (mg/l)
1	Pest, Inter, Form, Other	AL	96	--
2	Pest, Inter, Other	TF	NA	--
3	Pest, Inter, Form, Other	AL;AL	240;120	--
4	Pest, Inter, Form, Other	AS;TF	5	2,000
5	Pest, Inter	AL	2,280	--
6	Pest	AS	139	35,000
7	Pest, Inter, Form, Other	AS	7.15	6,000
8	Pest, Inter, Form, Other	AS;AL	79	>3,000
		AL	367	--
9	Pest, Inter, Form, Other	AL	2,160	--
		AS	55	2,000
10	Pest, Inter, Other	AL	NA	--
11	Pest, Form	AS	79	8,720
12	Pest, Other	AS	NA	NA
13	Pest, Inter, Form, Other	AL;AS	51.1	NA
14	Pest, Inter, Other	AS	60	NA
15	Pest, Inter, Form, Other	AL	288	--
16	Pest, Inter, Form	AL;TF	192	--
17	Pest, Inter, Form, Other	AS	NA	NA

Footnotes at end of table.

Table VI-16. Plants Using Biological Treatment for Pesticide Wastewaters
(Continued, page 2 of 2)

Plant Code	Products Manufactured	Type of System	Detention Time (Hours)	Activated Sludge MLSS (mg/l)
18	Pest, Inter, Form, Other	AS	NA	NA
19	Pest, Other	AL	NA	--
20	Pest, Inter, Form	AL	NA	--
21	Pest, Other	AL	206	--
22	Pest, Other	AL	NA	--
23	Pest, Inter, Other	AS	NA	NA
24	Pest, Other	AS	NA	NA
25	Pest, Inter, Form, Other	AL	NA	--
26	Pest, Inter, Form, Other	AS	24	NA
27	Pest, Inter, Other	AL;AS	NA	NA
28	Pest, Other	AL	420	--
29	Pest, Inter, Other	AS	NA	NA
30	Pest, Inter, Form, Other	AL	NA	--
31	Pest, Inter, Other	AS	NA	NA
32	Pest	AS;TF	3.2	NA

Pest = Pesticides
Inter = Pesticide Intermediates
Form = Pesticide Formulations
NA = Not Available
AS = Activated Sludge
AL = Aerated Lagoon
TF = Trickling Filter
MLSS = Mixed-Liquor Suspended Solids
Other = Manufacture of other chemical products

Table VI-17. Biological Treatment Operating Data

CONVENTIONAL POLLUTANTS

BOD				TSS			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	92.0*	39.0*	57.6	1	NA	18.0*	NA
1	179*	15.3*	91.4	1	NA	22.8*	NA
3	1940*	96.5*	95.0	3	269*	50.1*	81.4
3	2082*	122*	94.1	3	375*	66.8*	82.2
4	120*	8.0*	93.3	4	59.0*	39.0*	33.9
5	4320	1820	57.9	5	NA	501	NA
6	NA	12.7*	NA	5	360	NA	NA
7	928*	73.6*	92.1	6	NA	20.8*	NA
9	19.0*	<1.0*	>94.7	7	595	62.5	89.5
9	675	29.6	95.6	8	5320*	NA	NA
11	694*	12.2*	98.3	9	38.7	101	+
13	610*	7.0*	98.8	9	47.6*	35.0*	26.5
15	1131*	NA	NA	11	39.2*	28.4*	27.5
16	NA	253	NA	13	3.0*	1.8*	40.0
18	572*	NA	NA	15	1394*	NA	NA
20	NA	74.3	NA	18	350*	NA	NA
20	1000	NA	NA	20	NA	81.2	NA
20	2000	NA	NA	20	100	NA	NA
26	905*	114*	87.4	20	300	NA	NA
28	2000*	50.0*	97.5	26	140*	27.3*	80.5
29	7200*	NA	NA	26	340*	64.0*	81.2
				28	<100*	92.0*	<8.00

NA = Not available.
* = Data from comingled waste stream.
+ = Concentration increased.

Table VI-17. Biological Treatment Operating Data (Continued, Page 2 of 13)

NONCONVENTIONAL POLLUTANTS

COD			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	429	299	30.3
3	5870*	2320*	60.5
5	9740	3390	65.2
6	436*	127*	70.9
7	4290*	1280*	70.2
8	5250*	NA	NA
9	137*	60.3*	56.0
9	1480	537	63.7
11	1550*	160*	89.7
13	1600*	290*	81.9
15	2382*	NA	NA
18	5800*	NA	NA
20	NA	515	NA
20	2450	NA	NA
20	4900	NA	NA
21	2191*	394*	82.0
22	5250	NA	NA
26	2630*	519*	80.3
26	2830*	336*	88.1
28	4500*	770*	82.9
29	14000*	NA	NA

TOC			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
1	110*	104*	5.45
1	122*	NA	NA
3	1810*	621*	65.7
8	3230*	NA	NA
26	900*	100*	88.9
26	3680*	136*	96.3

TOD			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	7430	3094*	58.4
13	NA	408*	NA

NA = Not available.
* = Data from comingled waste stream.

Table VI-17. Biological Treatment Operating Data (Continued, Page 3 of 13)

MANUFACTURED PESTICIDES

Plant	Pesticides Influent mg/l	Pesticides Effluent mg/l	Percent Removal	Plant	Pesticides (Continued) Influent mg/l	Pesticides (Continued) Effluent mg/l	Percent Removal
1	NA	0.0452	NA	7	<0.0336	<0.0394	+
1	NA	0.0452	NA	7	0.0817	0.067	18.0
2	1.56	0.101	93.5	7	0.0918	0.0197	78.5
2	12.2	<0.00183	>99.9	7	0.189	0.148	21.7
3	0.00213	0.00175	17.8	7	0.439	0.0836	81.0
3	0.00846	0.00149	82.4	7	0.753	0.0946	87.4
3	0.615	0.0554	91.0	7	<0.820	<0.254	69.0
3	<0.684	0.533	22.1	7	<0.850	<0.105	87.6
3	<3.67	<1.62	55.9	7	1.03	<0.129	87.5
3	<4.93	<4.17	15.4	7	3.02	0.0685	97.7
3	<6.32	<4.19	33.7	7	3.58	0.49	86.3
3	<6.64	<4.31	35.1	8	1100	114	89.6
3	<7.67	<4.67	39.1	9	NA	<0.012	NA
3	<8.51	<5.37	36.9	9	NA	<0.011	NA
3	<15.8	<14.5	8.23	9	NA	<0.5	NA
3	<17.7	<18.4	+	9	NA	<0.01	NA
3	<23.5	<27.0	+	9	<0.10	<0.10	NA
3	45.9	0.184	99.6	11	3.56	2.08	41.6
4	0.023	<0.01	>56.5	11	13.8	10.3	25.3
4	0.120	0.05	58.3	11	18.0	0.012	99.9
4	0.20	<0.0001	>99.9	11	30.3	NA	NA
4	0.470	<0.010	>97.9	11	104	NA	NA
4	0.240	<0.0001	>99.9	11	136	NA	NA
4	1.11	0.011	99.0	13	0.207	0.164	20.8
4	3.00	<0.010	>99.7	13	1.48*	0.783*	47.1
5	0.084	0.0093	88.9	13	1.48*	0.783*	47.1
5	0.0507	0.0169	66.7	13	19.9	3.20	83.9
6	12.2†	<0.01†	>99.9	13	29.0	<1.0	>96.5
6	12.2†	<0.01†	>99.9	13	180	1.67	99.1
7	<0.010	<0.010	NA	13	6.84	<0.279	>95.9
7	0.019	0.027	+	13	2.80	0.255	90.9
				13	26.2	15.3	41.6

NA = Not available.
ND = Not detected.
+ = Concentration increased.
* = Data from comingled waste stream.
† = Hydrolysis and biological oxidation treatment combined.

Table VI-17. Biological Treatment Operating Data (Continued, Page 4 of 13)

MANUFACTURED PESTICIDES (Continued)

	Pesticides (Continued)		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
13	292	1.40	99.5
13	326	<2.0	>99.4
16	NA	0.023	NA
16	NA	0.023	NA
20	NA	<0.05	NA
20	NA	<0.05	NA
20	NA	<0.2	NA
21	0.58*	0.35*	39.6
22	NA	<1.0	NA
26	3.63	0.88	75.7
26	3.05*	0.378*	87.6
26	3.05*	0.378*	87.6
26	0.979*	0.362*	63.0
26	0.979*	0.362*	63.0
26	9.40*	0.170*	98.2
26	5.90*	0.080*	98.6
28	16.0	10.0	37.5

NA = Not available.
ND = Not detected.
* = Data from comingled waste stream.

Table VI-17. Biological Treatment Operating Data (Continued, Page 5 of 13)

VOLATILE AROMATICS

Benzene				Toluene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	2.68*	<0.01*	>99.6	3	15.3*	<0.01*	>99.9
4	0.220*	<0.01*	>95.4	4	5.40*	<0.01*	>99.8
4	52.0*	NA	NA	6	0.10*	0.009*	91.0
6	0.07*	0.005*	92.9	7	0.21*	0.021*	90.0
7	0.057*	0.16*	+	10	0.00103*	0.0347*	+
26	<0.050	<0.050	NA	13	1.4*	ND	NA
26	0.005*	ND*	NA	13	7.42*	<0.01*	>99.9
				25	<69.3	<9.6	86.1
				26	<0.20*	<0.20*	NA
				26	0.150*	0.005*	96.7

Chlorobenzene				Ethylbenzene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.005*	NA	NA	4	7.90*	ND	NA
4	3.0*	<0.01*	>99.7	10	<0.001*	<0.001*	NA
4	135.0*	NA	NA	13	0.20	<0.01	>95.0
6	0.3*	0.76*	+				
9	ND*	ND*	NA				
13	3.80*	<0.01*	>99.7				
13	5.0*	<0.02*	>99.6				
26	ND*	ND*	NA				

NA = Not available.
ND = Not detected.
* = Data from comingled waste stream.
+ = Concentration increased.

Table VI-17. Biological Treatment Operating Data (Continued, Page 6 of 13)

VOLATILE AROMATICS (Continued)

1,2-Dichlorobenzene				1,3-Dichlorobenzene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.023*	<0.01*†	>56.5	4	0.410*	0.013*	96.8

1,4-Dichlorobenzene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.470*	<0.01*†	>97.9

HALOMETHANES

Methyl chloride				Methylene chloride			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
6	ND	ND	NA	4	0.260*	0.190*	26.9
9	ND°	ND°	NA	7	0.55*	0.24*	56.4
				9	<0.464*	<0.10*	78.4
				10	<0.001*	0.172*	+
				11	0.017*	0.020*	+
				13	76.0*°	<1.1*	>98.5
				26	0.030*	0.010*	66.7
				26	<0.25*	<0.100*	60.0

NA = Not available.
ND = Not detected.
* = Data from comingled waste stream.
+ = Concentration increased.
° = Analysis not conducted per protocol.
† = Data from combined dichlorobenzenes: 1,2; 1,3; 1,4.

Table VI-17. Biological Treatment Operating Data (Continued, Page 7 of 13)

HALOMETHANES (Continued)

Plant	Chloroform Influent mg/l	Chloroform Effluent mg/l	Chloroform Percent Removal	Plant	Carbon tetrachloride Influent mg/l	Carbon tetrachloride Effluent mg/l	Carbon tetrachloride Percent Removal
3	0.0149*	<0.01*	>32.9	4	1.00*	0.270*	73.0
4	0.022*	NA	NA	13	Trace	Trace	NA
4	0.120*	0.032*	73.3				
4	2.8	NA	NA				
6	0.017	<0.01	>41.2				
7	0.04*	0.06*	+				
7	0.20*	NA	NA				
9	<0.571*°	ND*	NA				
10	<0.001*	<0.001*	NA				
13	0.455*	<0.01*	>97.8				
13	0.867*	<0.01*	>98.8				
26	0.080*	0.020*	75.0				
26	<0.80	<0.30	62.5				

CYANIDE

Plant	Cyanide Influent mg/l	Cyanide Effluent mg/l	Cyanide Percent Removal
3	1.22*	0.682*	44.1
3	2.16*	0.337*	84.4
3	5.04	NA	NA
7	0.067*	0.065*	2.98
9	0.0959	0.071	26.0
13	0.92*°	0.404*°	56.1

NA = Not available.
ND = Not detected.
* = Data from comingled waste stream.
+ = Concentration increased.
° = Analysis not conducted per protocol.

Table VI-17. Biological Treatment Operating Data (Continued, Page 8 of 13)

HALOETHERS

Plant	Bis(2-chloroethyl) ether Influent mg/l	Effluent mg/l	Percent Removal
2	0.582	0.0527	90.9

PHENOLS

Plant	Phenol Influent mg/l	Effluent mg/l	Percent Removal	Plant	2-Chlorophenol Influent mg/l	Effluent mg/l	Percent Removal
1	NA	0.004*	NA	4	0.062*	<0.01*	>83.9
1	0.058*	4.0*	+	4	<5.0*	NA	NA
4	0.290*	<0.01*	>96.5				
4	16.0	NA	NA				
4	16.0	NA	NA				
4	47.0*	NA	NA				
7	0.270*	0.042*	84.4				
16	1100*	2.03*	99.8				
21	61.8*	<3.84*	>93.8				
28	0.01*	0.09*	+				

NA = Not available.
* = Data from comingled waste stream.
+ = Concentration increased.

Table VI-17. Biological Treatment Operating Data (Continued, Page 9 of 13)

PHENOLS (Continued)

2,4-Dichlorophenol				2,4,6-Trichlorophenol			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.290*	0.018*	93.8	4	0.110*	0.180*	+
4	<5.0	NA	NA	4	3.0*	NA	NA
4	15.0*	NA	NA	4	<5.0	NA	NA
4	>1000	NA	NA	4	<100	NA	NA
7	0.002*	NA	NA	7	0.022*	0.021*	4.54
7	0.042*	<0.001*	>97.6				

Pentachlorophenol				4-Nitrophenol			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.390*	0.230*	41.0	4	ND	<0.01*	NA
4	1.0*	NA	NA	5	203	10.7	94.7
4	>1000	NA	NA	5	174	<7.84	>95.5
21	0.58*	0.35*	39.6	6	461†	<1.0†	>99.8

2,4-Dinitrophenol			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
2	7.91	0.397	95.0

NA = Not available.
ND = Not detected.
* = Data from comingled waste stream.
+ = Concentration increased.
° = Analysis not conducted per protocol.
† = Hydrolysis and biological oxidation treatment combined.

Table VI-17. Biological Treatment Operating Data (Continued, Page 10 of 13)

POLYNUCLEAR AROMATIC HYDROCARBONS

	Naphthalene		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.066*	<0.01*	>84.8

METALS

	Copper		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.204*	0.114*	44.1
4	0.510*	0.110*	78.4
7	0.05*	0.06*	+
9	0.0575	0.112	+
9	0.093*	0.088*	5.38
10	0.065	1.66*	+
13	0.53	0.30	43,4

	Zinc		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.450*	0.400*	11.1
7	0.06	0.13	+
10	<0.0257	0.187*	+
13	0.530	0.120	77.4

	Cadmium		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.00723	0.0046	36.4
4	0.0021*	0.0017*	19.0
7	0.2	0.25	+
26	0.0003*	0.0001*	66.7
26	<0.00120	<0.00080	33.3

	Chromium		
Plant	Influent mg/l	Effluent mg/l	Percent Removal
3	0.0647	0.044	32.0
4	0.240*	0.049*	79.6
7	1.0	1.1	+
10	0.060	0.033*	45.0
13	0.280	0.120	57.1
26	0.041	0.007	82.9
26	0.048*	0.008*	83.3
26	0.059	<0.0075	>87.3

* = Data from comingled waste stream.
+ = Concentration increased.

Table VI-17. Biological Treatment Operating Data (Continued, Page 11 of 13)

METALS (Continued)

Plant	Lead Influent mg/l	Lead Effluent mg/l	Lead Percent Removal	Plant	Mercury Influent mg/l	Mercury Effluent mg/l	Mercury Percent Removal
3	0.0489	0.0683	+	13	0.0008	<0.0004	>50.0
4	0.032*	0.0038*	88.1				
7	0.003	0.003	0.0				
13	0.065	0.018	72.3				
26	0.011*	0.0048*	56.4				
26	0.024	<0.001	>95.8				
26	0.0243	<0.001	>95.9				

Plant	Nickel Influent mg/l	Nickel Effluent mg/l	Nickel Percent Removal
3	0.331	0.286	13.6
7	0.45	0.45	0.0
13	0.140	0.024	82.8

CHLORINATED ETHANES AND ETHYLENES

Plant	1,2-Dichloroethane Influent mg/l	1,2-Dichloroethane Effluent mg/l	1,2-Dichloroethane Percent Removal	Plant	1,1,1-Trichloroethane Influent mg/l	1,1,1-Trichloroethane Effluent mg/l	1,1,1-Trichloroethane Percent Removal
4	1.40*	0.580*	58.6	4	0.430*	0.022*	94.9
7	0.37*	0.18*	51.3				
10	<0.0117*	<0.069*	+				

* = Data from comingled waste stream.
+ = Concentration increased.

Table VI-17. Biological Treatment Operating Data (Continued, Page 12 of 13)

CHLORINATED ETHANES AND ETHYLENES (Continued)

Vinyl chloride				1,1-Dichloroethylene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.023*	<0.01*	>56.5	4	1.10*	0.041*	96.3

1,2-trans-Dichloroethylene				Trichloroethylene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal	Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.011*	<0.01*	>9.09	4	0.034*	<0.01*	>70.6
7	0.17*	0.54*	+				

Tetrachloroethylene			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	0.330*	0.037*	88.8
7	2.47*	1.45*	41.3
7	0.37*	6.9*	+

PHTHALATES

Bis(2-ethylhexyl) phthalate			
Plant	Influent mg/l	Effluent mg/l	Percent Removal
4	<0.01*	0.028*	+

* = Data from comingled waste stream.
+ = Concentration increased.

Table VI-17. Biological Treatment Operating Data (Continued, Page 13 of 13)

AMMONIA

Plant	Ammonia Influent mg/l	Ammonia Effluent mg/l	Percent Removal
3	7.24	4.4	39.2

Table VI-18. Plants Disposing All Pesticide Wastewaters by Contract Hauling

Plant Code	Pesticide Code	Volume Disposed (MGD)	Pretreatment	Disposal Site/Method
1	A	0.01	NE,GS,SK,SP	City evaporation pond
	B	0.05	NE,GS,SK,SP	City evaporation pond
	C	0.06	MS,NE,GS,SK,SP	City evaporation pond
2	D	0.0163	NO	Sanitary landfill
3	E	0.00055	NE	Hazardous waste landfill
	F	0.00130	NE	Hazardous waste landfill
	G	0.00130	NE	Hazardous waste landfill
4	H	0.0000154	NE	Sanitary landfill
5	I	0.000086	NE	Sanitary landfill, deep well injection
6	J	Nil	NO	Sanitary landfill, deep well injection
7	K	0.0068	EQ,NE	Private waste treatment plant
8	L	0.000252	NO	Contract incineration
9	M	0.0001	NE	Contract incineration
	M	NA	NO	Contract incineration
	N	0.0009	NO	Contract incineration
	O	0.0002	NO	Contract incineration
	P	0.005	NO	Contract incineration
	Q	NA	NO	Contract incineration
	R	0.0002	NO	Contract incineration
	R	NA	NO	Contract incineration

EQ = Equalization
GS = Gravity Separation
MS = Metal Separation
NA = Not Available
NE = Neutralization
NO = None
SK = Skimming
SP = Stripping

Table VI-19. Plants Using Evaporation Ponds for Pesticide Wastewaters

Plant Code	Pesticide Code	Volume Disposed (MGD)	Net Evaporation (Inches/Yr)	Supplementary Design	Pretreatment
1	A	0.02	-12	Heat	HD, NE, CO, EQ
	B	0.015	-12	Heat	HD, NE, CO, EQ
2	C	0.01	-12	Aeration	AL
	D	0.001	-12	Aeration	AL
3	E	0.0072	-2	None	GS, NE
4	F	0.091	+13	Heat	SK, AL
5	G	0.002	+20	NA	NO
6	H	0.001	+69	NA	NE

\+ = Indicates precipitation is less than evaporation.
AL = Aerated Lagoon
CO = Chemical Oxidation
EQ = Equalization
GS = Gravity Separation
HD = Hydrolysis
NA = Not Available
NE = Neutralization
NO = None
SK = Skimming

Table VI-20. Plants Disposing Pesticide Wastewaters by Ocean Discharge

Plant Code	Pesticide Code	Flow (MGD)	Pretreatment
1	A	0.01009	None
	B	0.012	None
	C	0.005	None
	D	0.012	None
	E	0.008	None
	F	0.005	None

Table VI-21. Plants Using Deep Well Injection for Pesticide Wastewaters

Plant Code	Pesticide Code	Volume Injected (MGD)	Pretreatment
1	A	0.0072	NO
	B	0.0086	NO
	C	0.0720	NO
2	D	NA	GS
	D, H, I, and Q Combined Pesticide Processes	0.013	GS
	E	0.041	SE
	F	0.032	SE
	G	NA	NE
	H	NA	GS
	I	NA	GS
	J	NA	NE
	K	0.025	GS,NE
	L	0.0029	PF
	G, J, O, and P Combined Pesticide Processes	0.036	NE
	M	NA	NA
	N	0.010	NO
	O	NA	NE
	P	NA	NE
	Q	NA	GS
3	R	Nil	GS,MF,GS
	Pesticide intermediate	0.010	GS,MF,GS
4	S	NA	NO
5	T	0.0072	NE
	U	0.0072	NE
6	V	0.07	NE,PF
	W	0.08	NE,PF
7	X	0.30	NE,PF
8	Y	0.01	NE,CA,SK,GS,PF, EQ

Footnotes at end of table.

Table VI-21. Plants Using Deep Well Injection for Pesticide Wastewaters (Continued, Page 2 of 2)

Plant Code	Pesticide Code	Volume Injected (MGD)	Pretreatment
9	Z	0.01	SK,GS,PF
	AA	0.04	SK,GS,PF,GS
	BB	0.04	SK,GS,PF,GS
	CC	0.04	SK,GS,PF,GS
	DD	0.01	SK,NE,GS,PF
	EE	0.04	SK,GS,PF,GS
	FF	0.04	SK,GS,PF,GS
	GG	0.01	SK,NE,GS,PF,GS
	HH	0.04	SK,GS,PF,GS
10	II	0.0015	AP
	JJ	0.015	AP
	KK	0.005	AP
11	LL	0.328	PF
12	MM	0.0072	NO
13	NN	0.00125	NO
14	OO	0.014	NE,GS,SE,GS,NE, PF
15	PP	0.073	GS,PF
	QQ	0.0095	NE,GS,PF
16	RR	0.0533	GS,SK
17	SS	NA	NO
	TT	NA	NO

AP = API Type Separator
CA = Coagulation
EQ = Equalization
GS = Gravity Separation
MF = Multimedia Filtration
NA = Not available
NE = Neutralization
NO = None
PF = Pressure Leaf Filter
SE = Solvent Extraction
SK = Skimming

Table VI-22. Recommended Treatment Technology for Priority Pollutant Groups

Pollutant Group	Treatment Technology												
	Activated Carbon	Resin Adsorption	Steam Stripping	Hydrolysis	Biological Oxidation	Wet Air Oxidation	Membrane Processes	Metals Separation	Solvent Extraction	Chemical Oxidation	Filtration	Powdered Activated Carbon	Tertiary Carbon
Volatile Aromatics	x	x	1	x	2	x	x	x	x	x	x	x	2
Halomethanes	x	x	1	x	2	x	x	x	x	x	x	x	2
Cyanides	x	x	x	x	2	x	x	x	x	1	x	x	2
Haloethers	x	x	1	x	2	x	x	x	x	x	x	x	2
Phenols	1	1	x	x	2	x	x	x	x	x	x	x	2
Nitro Substituted Aromatics	x	x	1	x	2	x	x	x	x	x	x	x	2
Polynuclear Aromatics	x	x	x	x	2	x	x	x	x	x	x	x	2
Metals	x	x	x	x	2	x	x	1	x	x	2	x	2
Chlorinated ethanes(ylenes)	x	x	1	x	2	x	x	x	x	x	x	x	2
Nitrosamines	1	x	x	x	2	x	x	x	x	x	x	x	2
Phthalates	x	x	x	x	2	x	x	x	x	x	x	x	2
Dichloropropane (ene)	x	x	1	x	2	x	x	x	x	x	x	x	2
Pesticides	1	1	x	1	2	x	x	x	x	1	x	x	2
Dienes	1	1	x	x	2	x	x	x	x	x	x	x	2
TCDD	1	x	x	x	x	x	x	x	x	x	x	x	2
Miscellaneous	—	—	—	—	—	--	—	—	—	—	--	--	--
PCBs	—	—	—	—	—	--	—	—	—	--	—	—	--
Benzidines	—	—	—	—	—	--	—	—	—	--	--	--	--

1 = Primary removal technology.
2 = Secondary removal technology.
— = Pollutant group not likely to be present.
x = Indicates technology was considered but was not a primary or secondary recommendation.

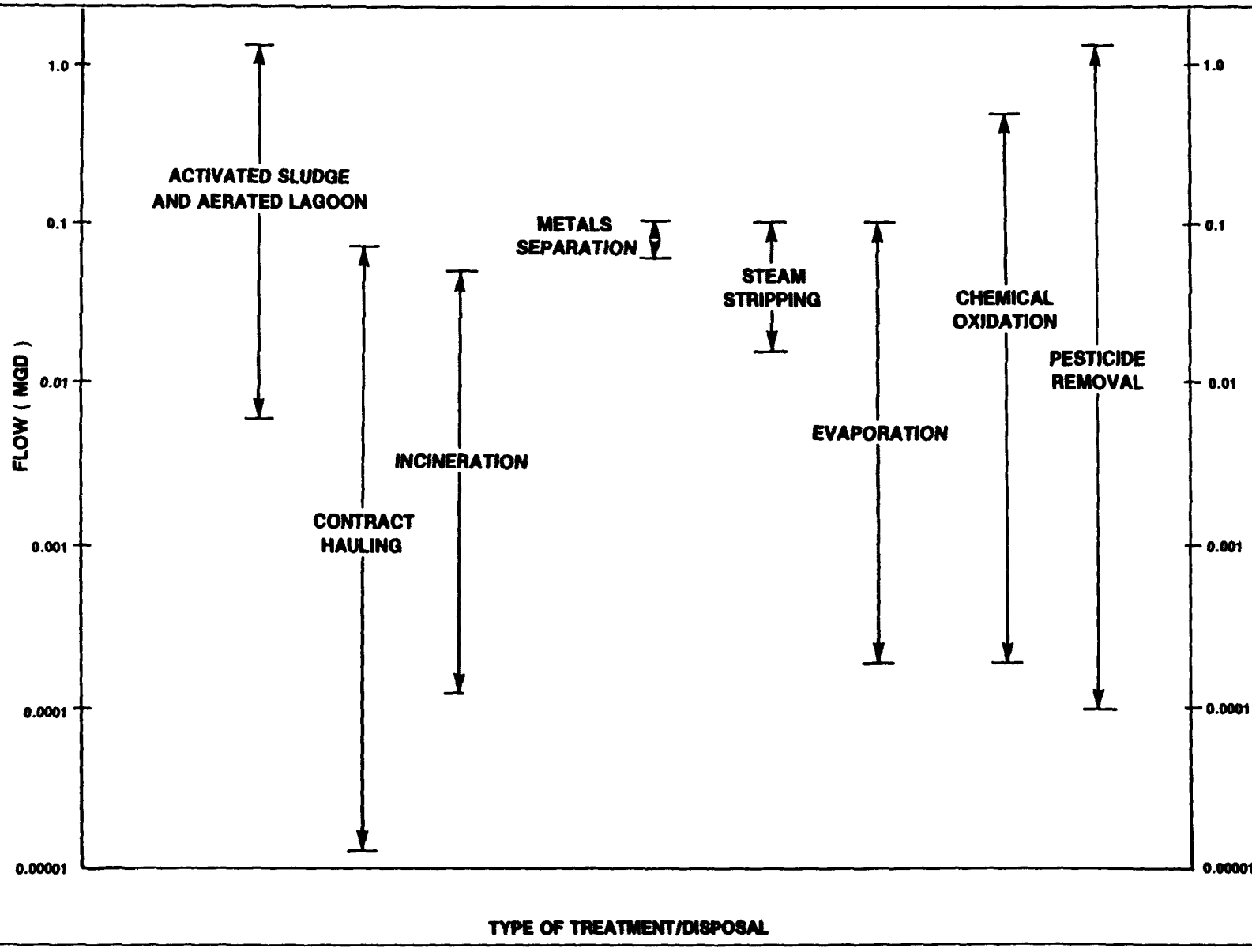


FIGURE VI-1 RANGE OF FLOWS FOR PESTICIDE TREATMENT/DISPOSAL

DESIGN CRITERIA

8 HOURS OF SERVICE TIME
THREE PUMPS AT 50% OF TOTAL FLOW EACH
PUMPING HEAD = 20 ft.
PUMP EFFICIENCY = 85%
WET WELL CAPACITY = 0.5% OF DAILY FLOW

FLOW DIAGRAM

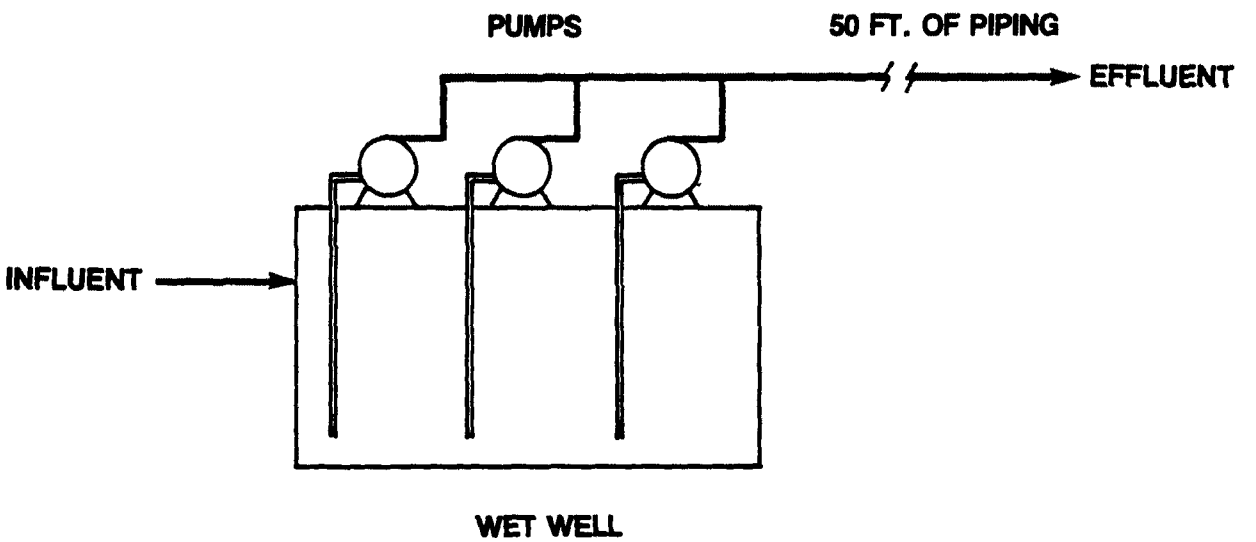


Figure VI-2 RECOMMENDED BAT TECHNOLOGY
PUMP STATION

DESIGN CRITERIA

USE AT LEAST TWO BASINS
AERATION AND MIXING = 75 HP/MG
DETENTION TIME ALTERNATIVES = 12 HOURS (BEFORE PRETREATMENT)
24 HOURS (BEFORE BIOLOGICAL TREATMENT)

FLOW DIAGRAM

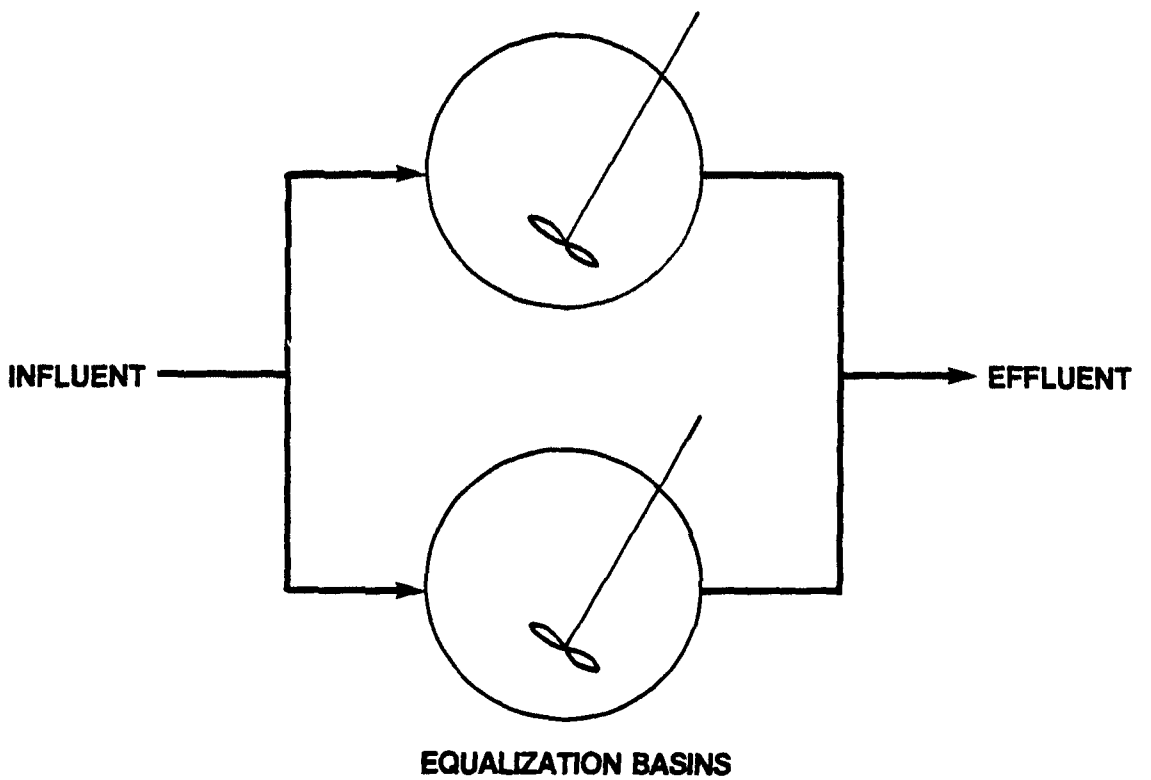


Figure VI-3 RECOMMENDED BAT TECHNOLOGY
EQUALIZATION

DESIGN CRITERIA

THEORETICAL TRAYS= 3 APPROX.
TRAY EFFICIENCY= 12%
REFLUX IS 25% OF FEED
INFLUENT CONCENTRATION = SOLUBILITY OF VOLATILES (PPM)
EFFLUENT CONCENTRATION = 1 PPM

FLOW DIAGRAM

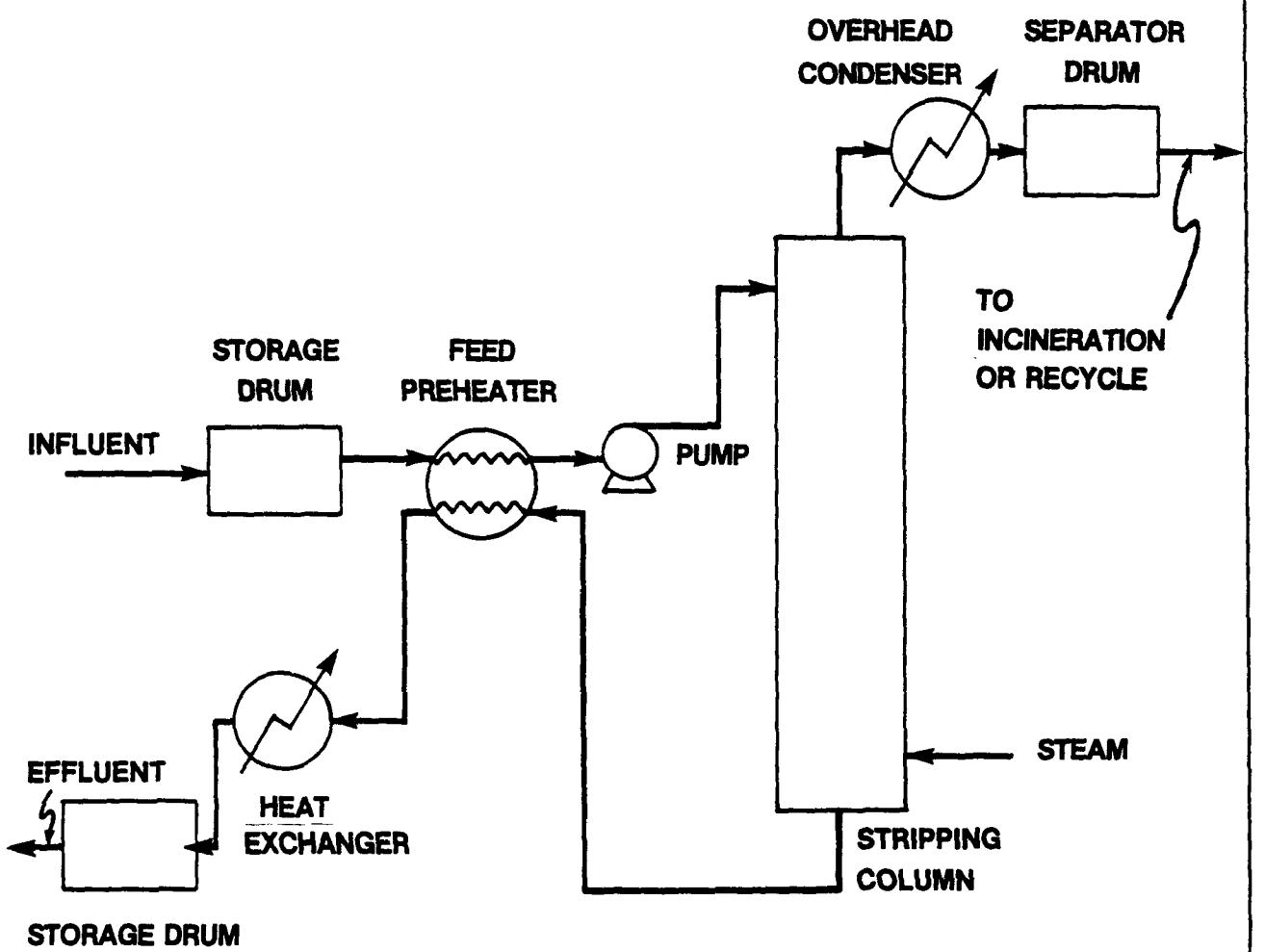


Figure VI-4 RECOMMENDED BAT TECHNOLOGY
STEAM STRIPPING

DESIGN CRITERIA

USE TWO BATCH VESSELS WITH 24 HR. DETENTION TIME
REACTION TIME=4 HR.
CAUSTIC USAGE=3 PARTS/PART CN
CHLORINE USAGE=3 PARTS/PART CN
OPERATING RANGE=pH 8.5 TO 11.0

FLOW DIAGRAM

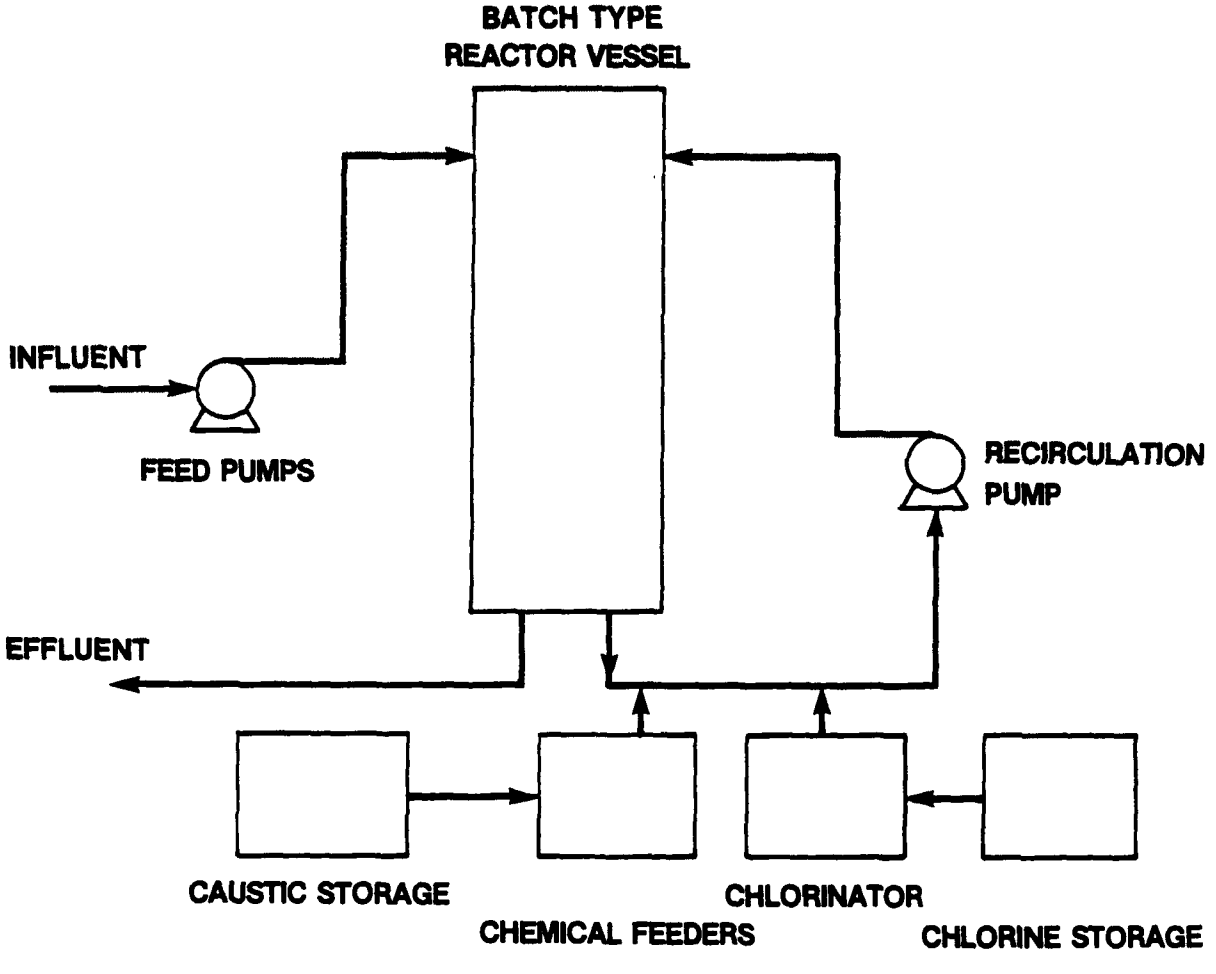


Figure VI-5 RECOMMENDED BAT TECHNOLOGY
ALKALINE CHLORINATION

DESIGN CRITERIA

MIXING TANK DETENTION TIME=24 HR
MIXING HORSEPOWER=72 HP/MGD
FILTER PRESS RUNTIME=8 HR
HOLDING TANK DETENTION TIME=24 HR
OPERATING pH=9.0
INFLUENT ZINC=245 MG/l: CAUSTIC ADDITION=6000 MG/l
INFLUENT COPPER=4500 MG/l:CAUSTIC ADDITION=110,000 MG/l

FLOW DIAGRAM

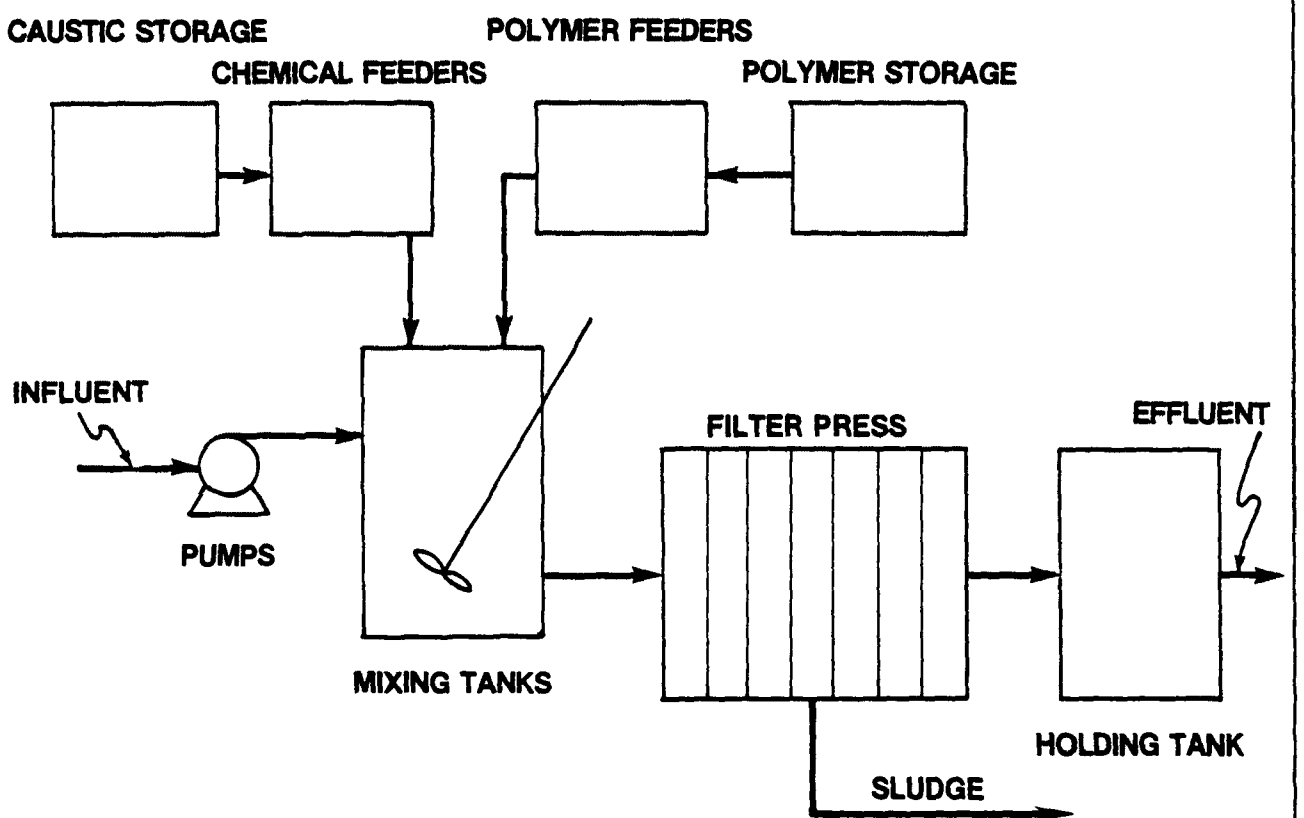


Figure VI-6 RECOMMENDED BAT TECHNOLOGY
METALS SEPARATION

DESIGN CRITERIA

USE TWO FLOW-THROUGH BASINS

BASIN LENGTH/WIDTH = 20/1 — INFLUENT T = 22°C = 72°F

BASIN LENGTH/DEPTH ≥ 20/1 — BASIN T = 40°C = 104°F

BASIN pH = 11

DETENTION TIME ALTERNATIVES — 0.28; 2.8; 6.9; 16.7 DAYS

FLOW DIAGRAM

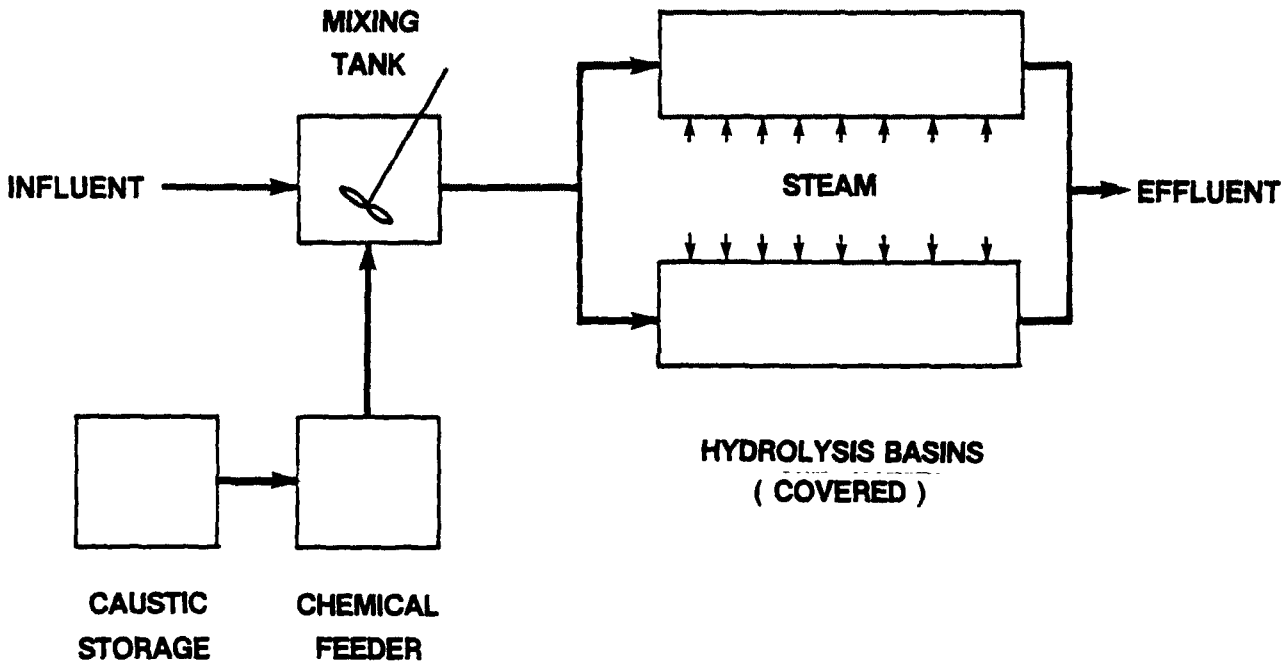


Figure VI-7 RECOMMENDED BAT TECHNOLOGY
PESTICIDE HYDROLYSIS

DESIGN CRITERIA

6 MIN. DETENTION TIME FOR MIXING TANK
CAUSTIC ADDITION=100 PPM
CAUSTIC STORAGE=30 DAYS

FLOW DIAGRAM

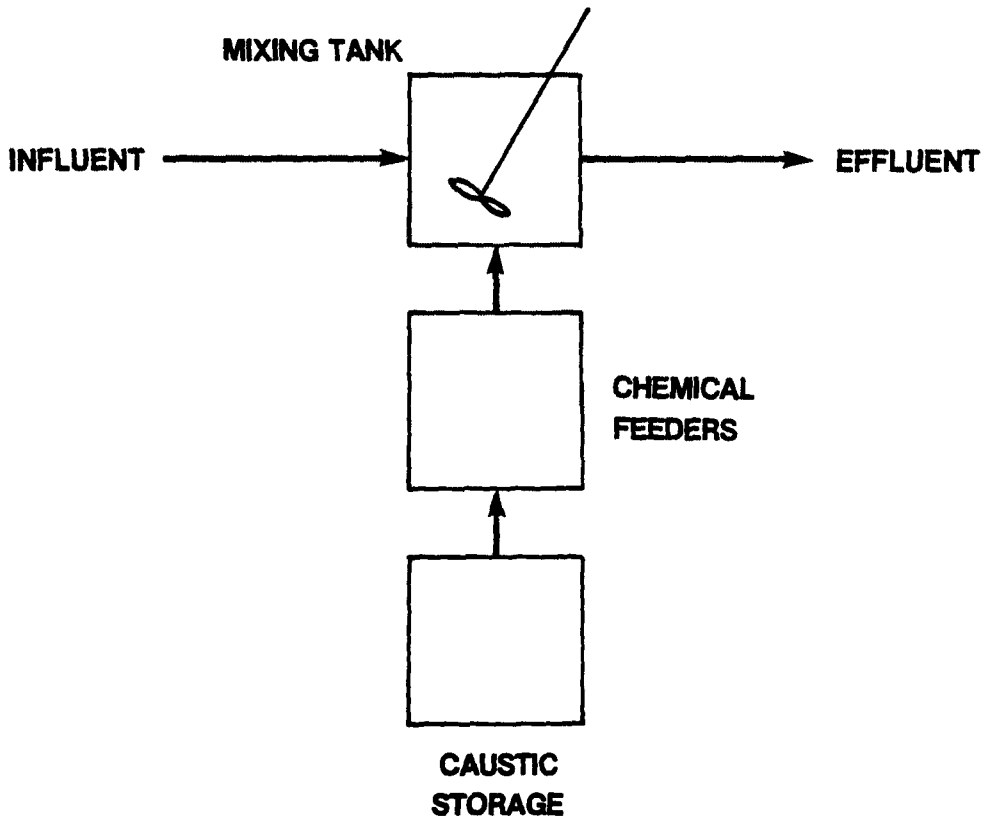


Figure VI-8 RECOMMENDED BAT TECHNOLOGY
NEUTRALIZATION

DESIGN CRITERIA

PUMPING HEAD = 20 FT.
FILTER RATE = 4 GAL/MIN/FT²
BACKWASH 2 FILTERS AT ONE TIME
BACKWASH RATE =20 GAL/MIN/FT²
BACKWASH HEAD = 30 FT.
RUN LENGTH = 12 HOURS
BACKWASH DURATION = 15 MIN.

FLOW DIAGRAM

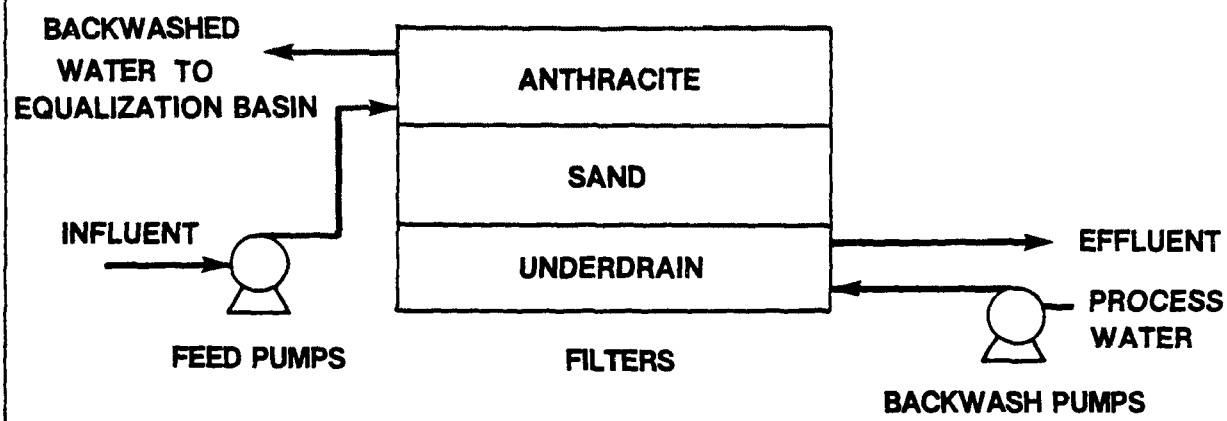


Figure VI-9 RECOMMENDED BAT TECHNOLOGY
DUAL MEDIA PRESSURE FILTRATION

DESIGN CRITERIA

SURFACE LOADING=0.5 GPM/FT ^{2} (PRIMARY USE)
SURFACE LOADING=4 GPM/FT^2 (TERTIARY USE)
BACKWASH RATE=20 GPM/FT^2
BACKWASH HEAD=15 FT.
TWO COLUMNS IN SERIES

FLOW DIAGRAM

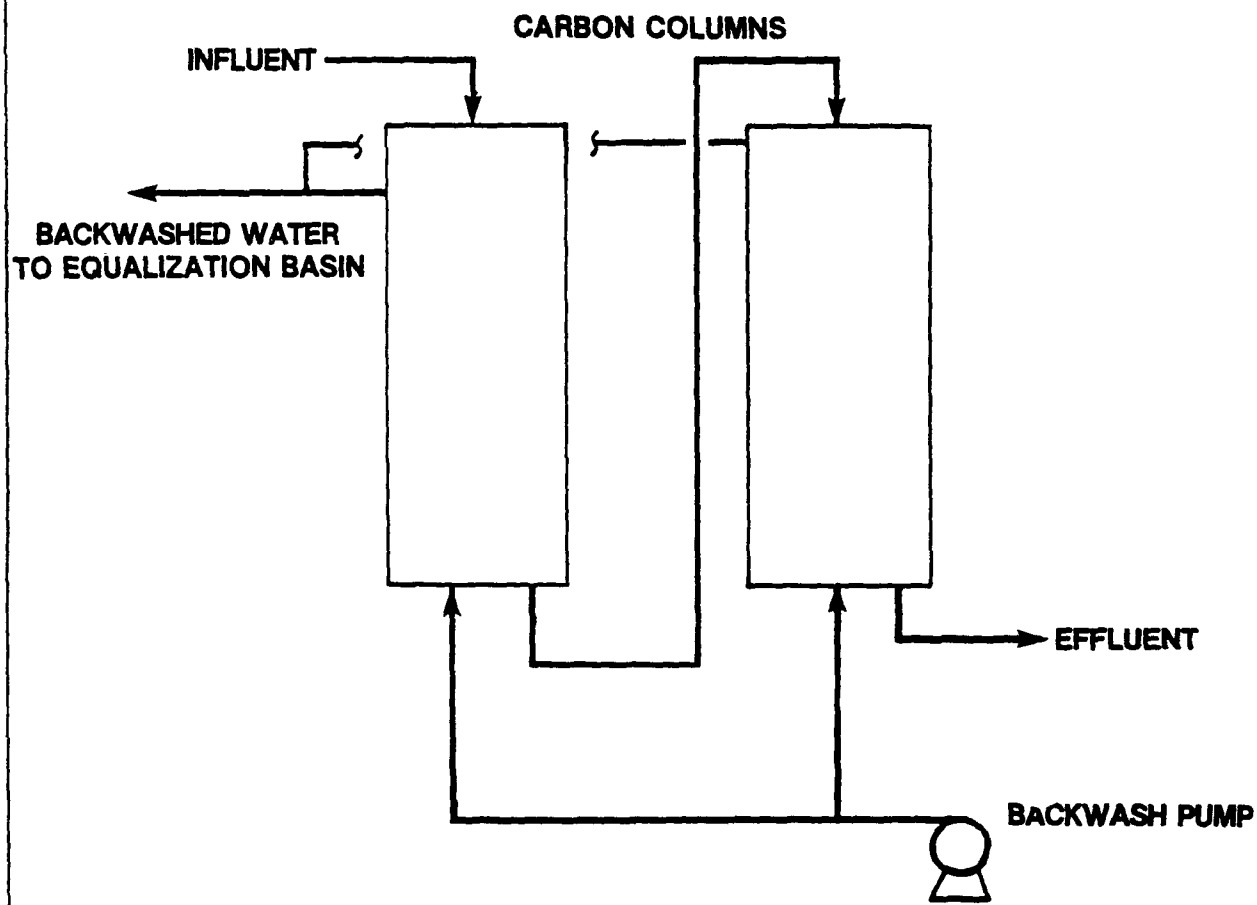


Figure VI-10 RECOMMENDED BAT TECHNOLOGY
CARBON ADSORPTION

DESIGN CRITERIA

CARBON USAGE = 100 LB/1000 GAL (PRIMARY USE)
CARBON USAGE = 30 LB/1000 GAL (TERTIARY USE)

FLOW DIAGRAM

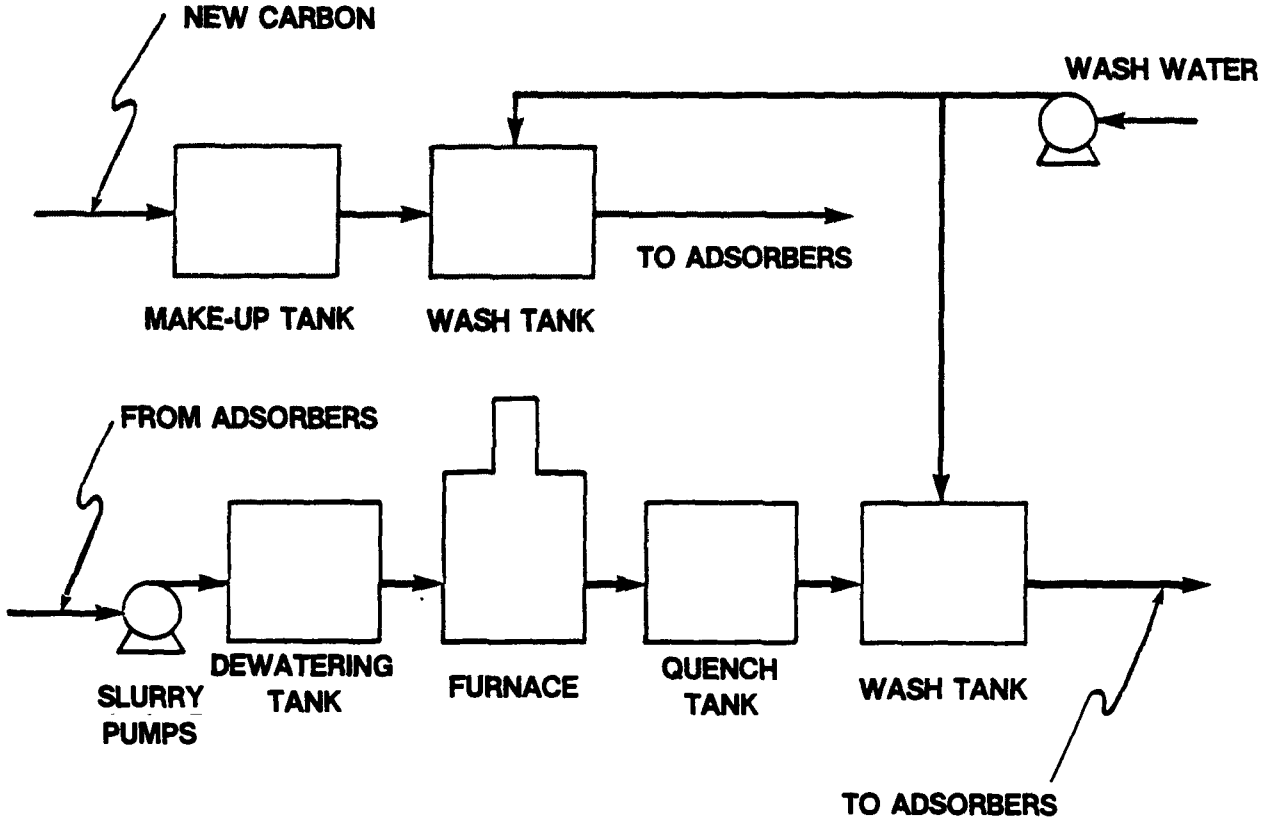


Figure VI-11 RECOMMENDED BAT TECHNOLOGY
CARBON REGENERATION

DESIGN CRITERIA

EMPTY BED CONTACT TIME = 15 MIN
SURFACE LOADING = 4 GPM/FT^2
USE TWO COLUMNS IN PARALLEL, ONE COLUMN SPARE

FLOW DIAGRAM

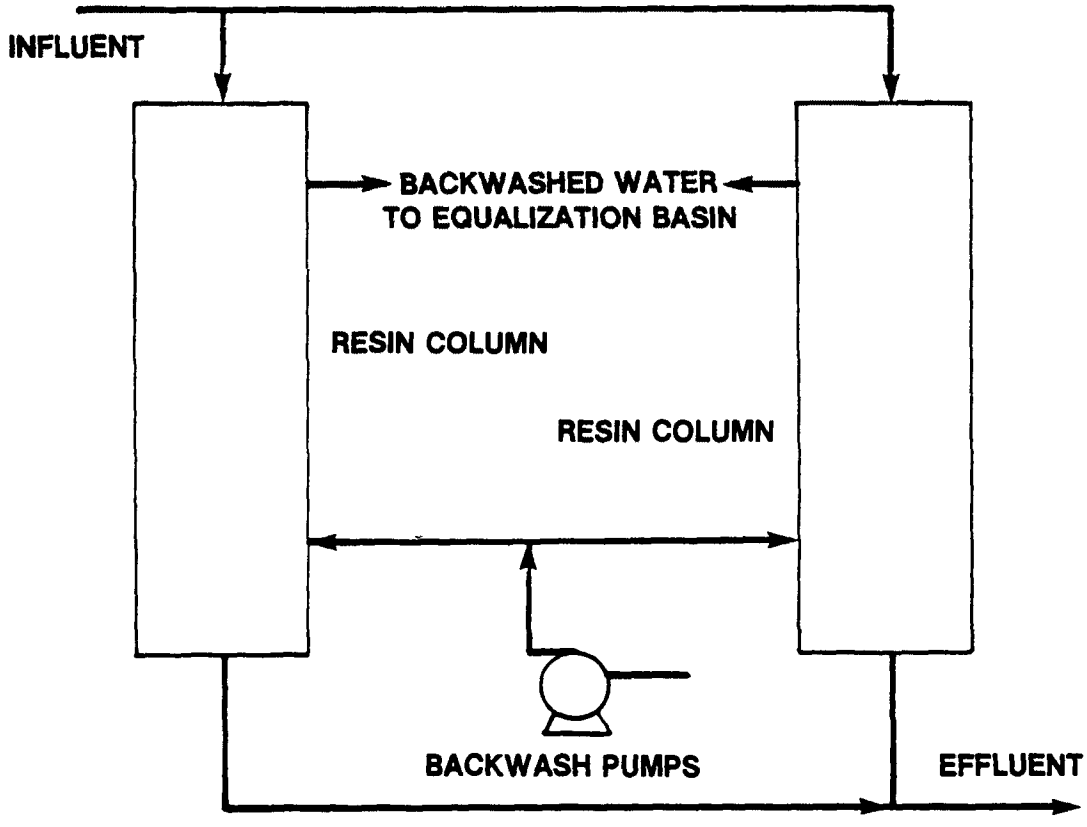


Figure VI-12 RECOMMENDED BAT TECHNOLOGY
RESIN ADSORPTION

DESIGN CRITERIA

REGENERATION FREQUENCY (PRIMARY) = TWICE DAILY
SOLVENT LOADING = 0.3 GPM/FT^2
PUMP HEAD = 20 FT
METHANOL LOSS = 1% YEARLY
BATCH DISTILLATION
REFLUX RATIO = 3/1

FLOW DIAGRAM

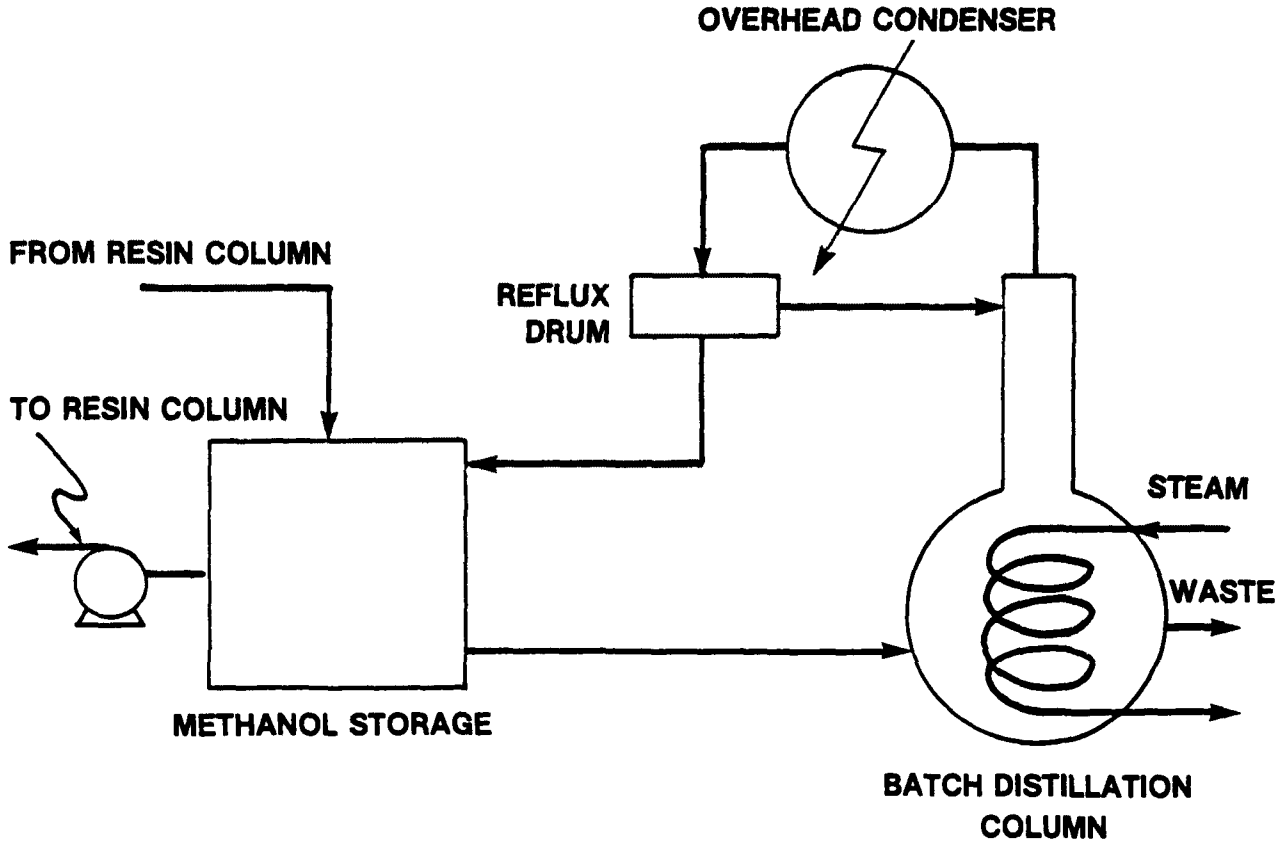


Figure VI-13 RECOMMENDED BAT TECHNOLOGY
RESIN REGENERATION

DESIGN CRITERIA

MAINTAIN BOD/P/N= 100/5/1

FLOW DIAGRAM

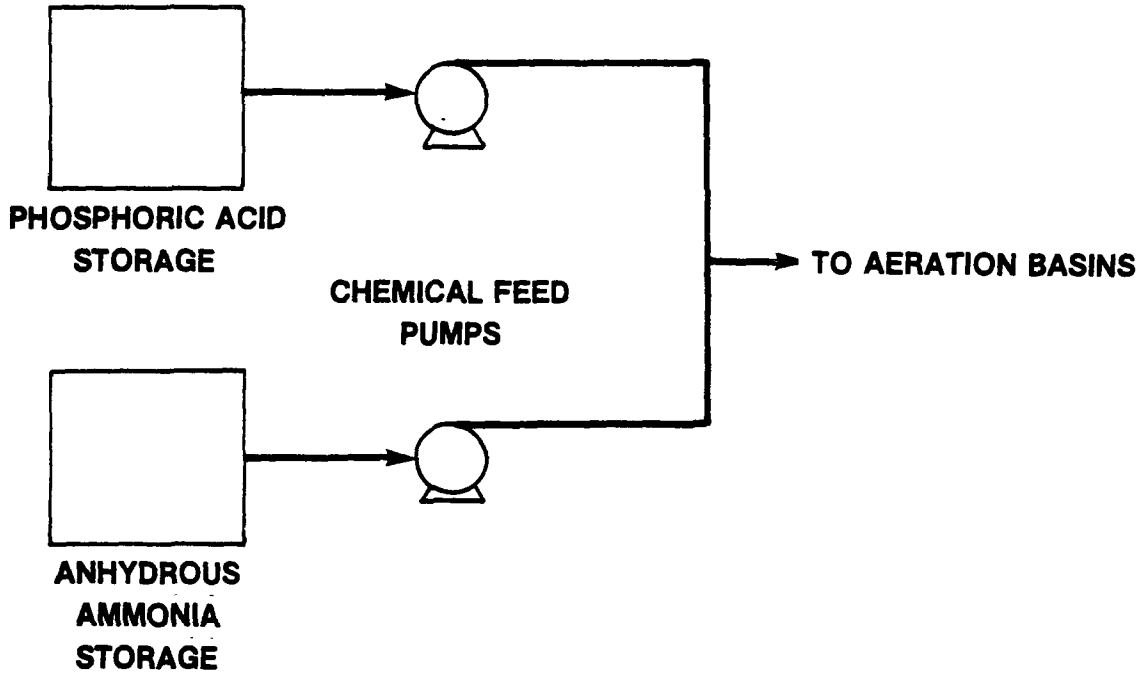


Figure VI-14 RECOMMENDED BAT TECHNOLOGY
NUTRIENT ADDITION

DESIGN CRITERIA

DETENTION TIME=3 DAYS
AERATION=100 HP/MG
USE TWO BASINS IN PARALLEL

FLOW DIAGRAM

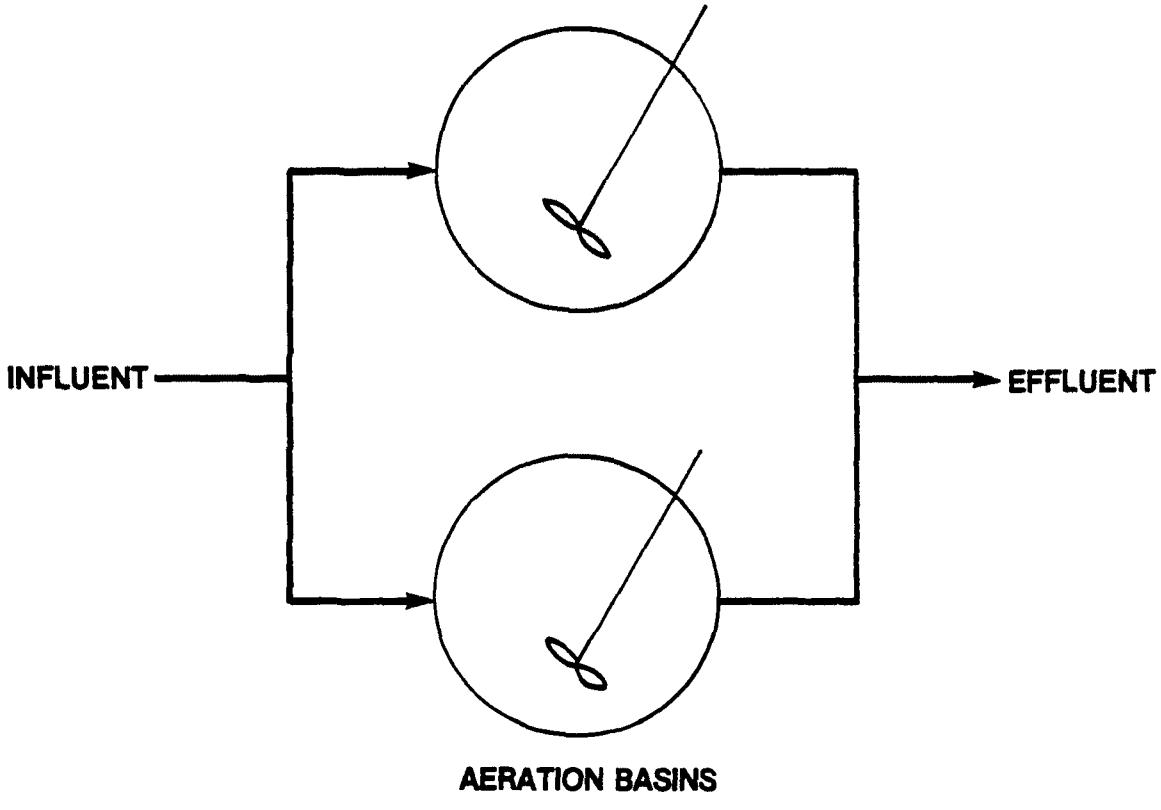


Figure VI-15 RECOMMENDED BAT TECHNOLOGY
AERATION BASIN

DESIGN CRITERIA

OVERFLOW RATE = 400 GPD/FT²
DEPTH = **12 FT.**
SLUDGE RETURN CAPACITY = 200%
MINIMUM OF TWO BASINS IN PARALLEL
POLYMER ADDITION AT 20 MG/l

FLOW DIAGRAM

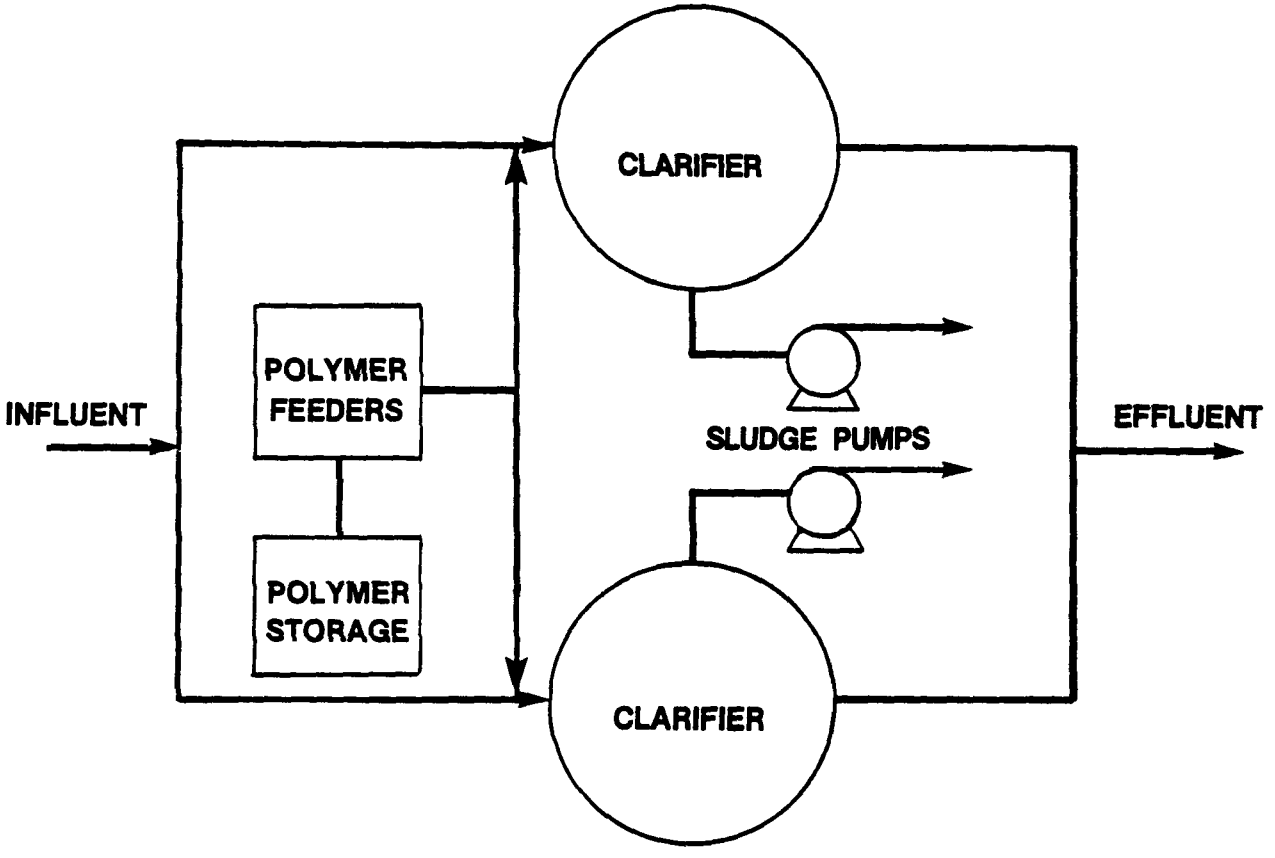


Figure VI-16 RECOMMENDED BAT TECHNOLOGY
CLARIFICATION

DESIGN CRITERIA

SURFACE LOADING = 0.4 GPM/FT²
SOLID LOADING = 10 LB/FT²/DAY
INFLUENT = 0.5% SOLIDS
EFFLUENT = 2.0% SOLIDS

FLOW DIAGRAM

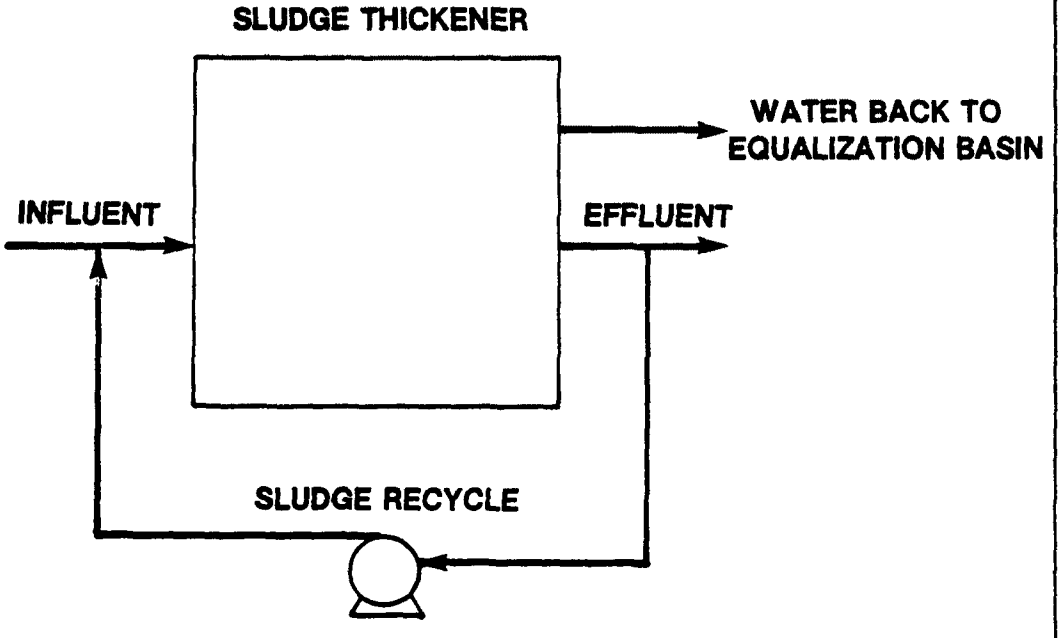


Figure VI-17 RECOMMENDED BAT TECHNOLOGY
SLUDGE THICKENER

DESIGN CRITERIA

DETENTION TIME = 20 DAYS
INFLUENT = 2% SOLIDS
EFFLUENT = 3.5% SOLIDS

FLOW DIAGRAM

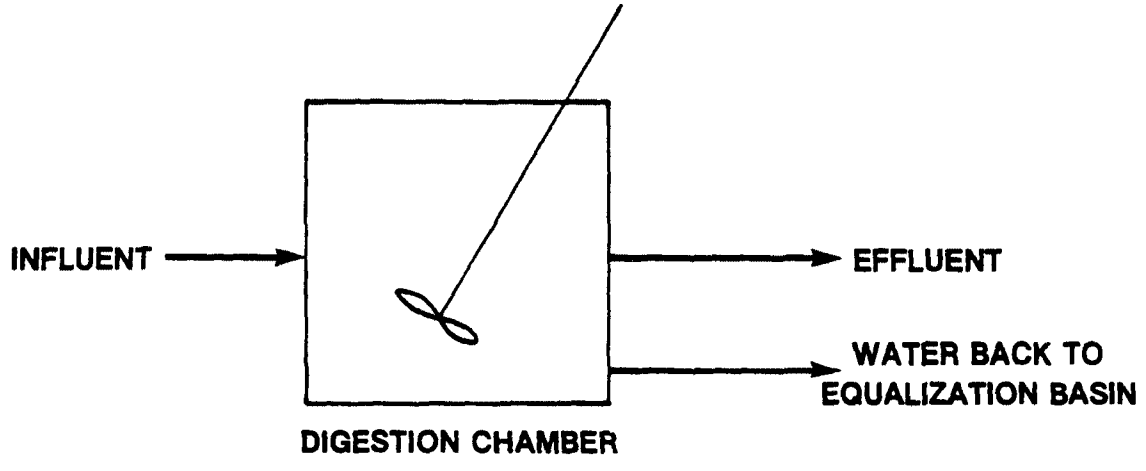


Figure VI-18 RECOMMENDED BAT TECHNOLOGY
AEROBIC DIGESTION

DESIGN CRITERIA

FERRIC CHLORIDE ADDITION = 7% OF DRY SOLIDS WEIGHT
EFFLUENT = 15% SOLIDS

FLOW DIAGRAM

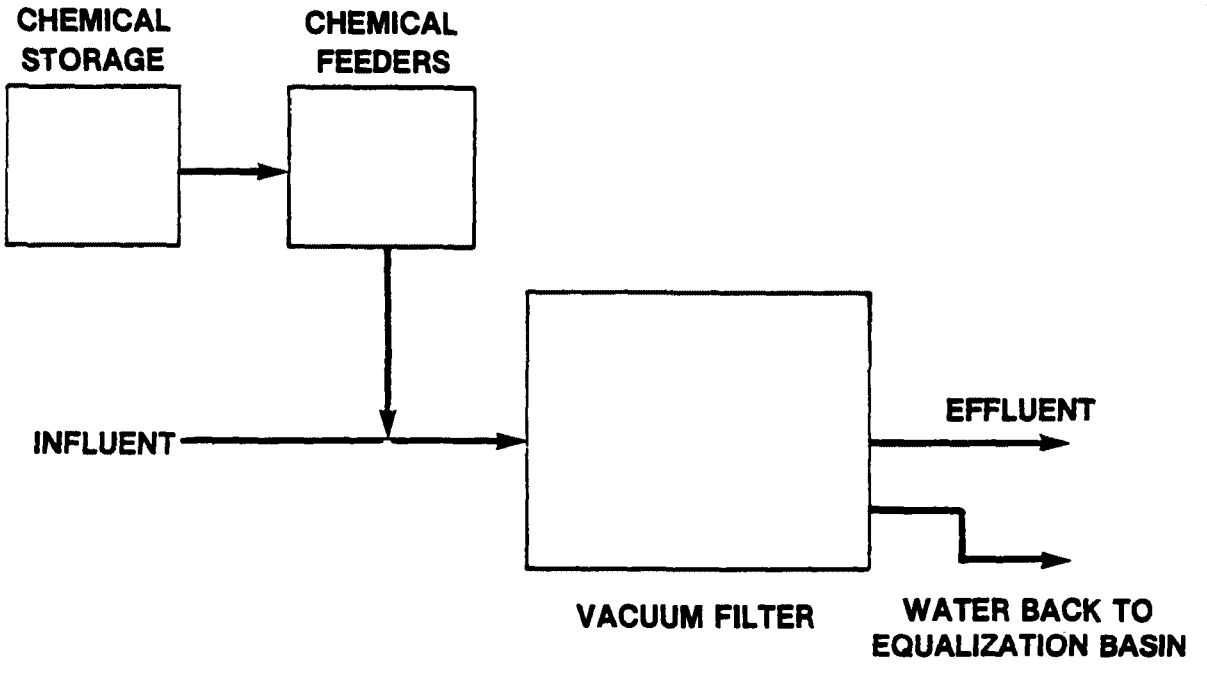


Figure VI-19 RECOMMENDED BAT TECHNOLOGY
VACUUM FILTRATION

DESIGN CRITERIA

CHLORINATED ORGANICS pH ADJUSTMENT FOR SMALL FLOWS WITH CAUSTIC

CHLORINATED ORGANICS pH ADJUSTMENT FOR LARGE FLOWS WITH LIME

STEAM RECOVERY INCLUDED

FLOW DIAGRAM

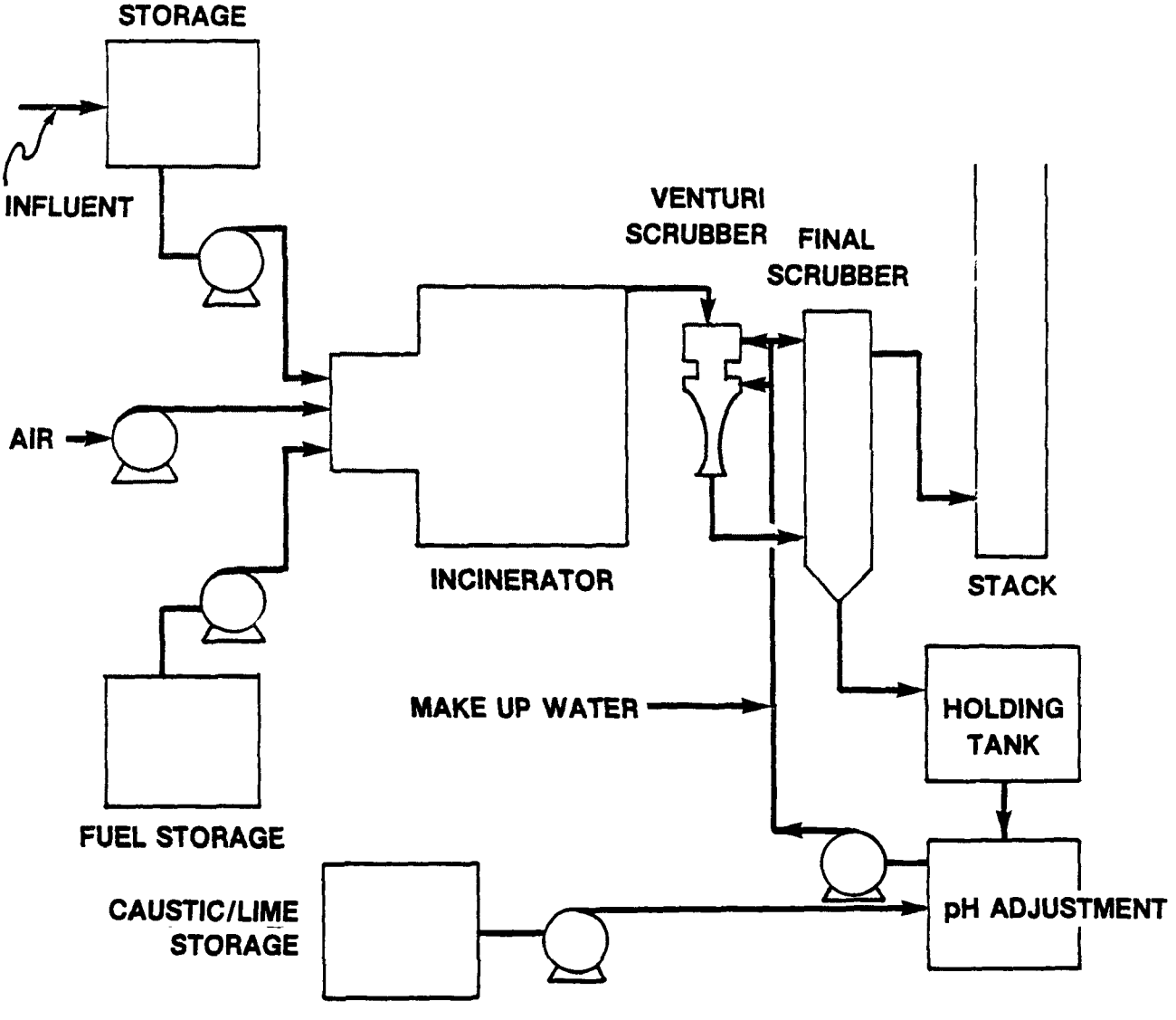


Figure VI-20 RECOMMENDED BAT TECHNOLOGY INCINERATION

DESIGN CRITERIA

SQUARE POND
AVG. WIND = 5 MPH
NOZZLE = 1/2 A25
NOZZLE HEIGHT = 10 FT
ATMOSPHERIC TEMP.=70°F
RELATIVE HUMIDITY = .05
RAINFALL= 40 IN/YR
ATMOSPHERIC PRESSURE = 1 ATM
SURFACE MASS TRANSFER COEFFICIENT = 0.8
SATURATION VAPOR PRESSURE = .024 ATM
NOZZLE PRESSURE = 10 psig, 5 psig

FLOW DIAGRAM

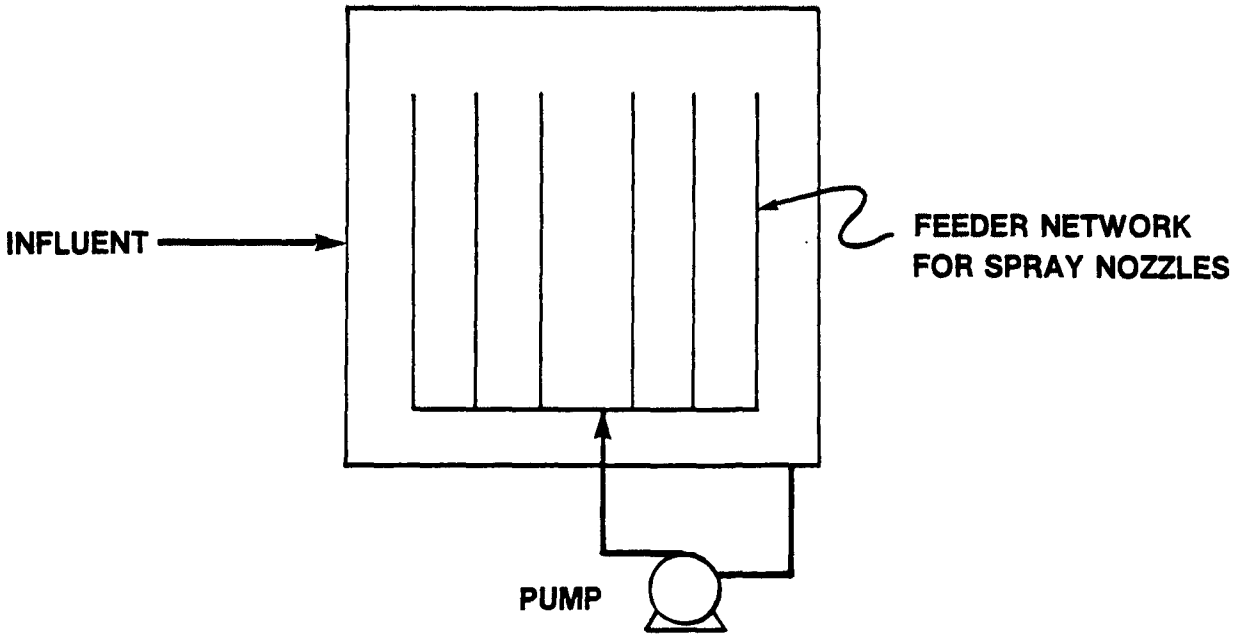
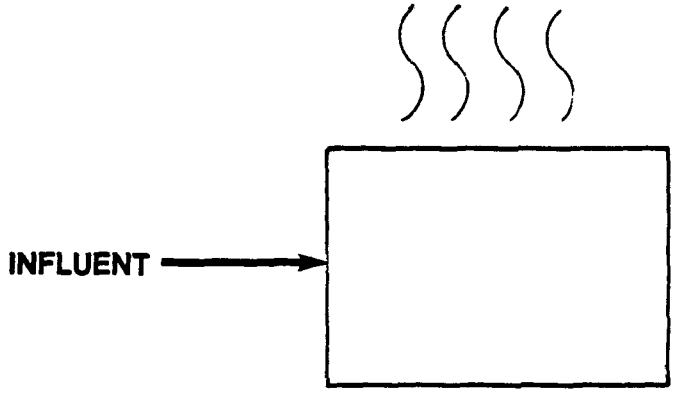


Figure VI-21 RECOMMENDED BAT TECHNOLOGY
SPRAY EVAPORATION POND

DESIGN CRITERIA

NET EVAPORATION = 5 IN/YR, 10 IN/YR, 20 IN/YR, 30 IN/YR
STORAGE FOR FOUR MONTHS PROVIDED AT -30 IN/YR

FLOW DIAGRAM



SOLAR EVAPORATION POND

Figure VI-22 RECOMMENDED BAT TECHNOLOGY
SOLAR EVAPORATION

SECTION VII

INDUSTRIAL SUBCATEGORIZATION

FACTORS CONSIDERED

The purpose of this section is to provide the rationale for the placement of individual pesticides into proposed subcategories. The subcategorization scheme was developed to evaluate each pesticide product in a manner that was functionally feasible as well as fair and equitable. The differences in types of pollutants regulated, effluent levels achievable, and/or costs to reach that level resulted in a proposal that manufactured pesticides be placed in one of 11 subcategories. This section also provides the rationale for the placement of pesticide manufacturers of mercury, copper, cadmium, and arsenic-based pesticide products and formulator/packagers into separate subcategories, numbered 12 and 13.

The subcategorization proposed for this industry is based primarily upon the priority pollutants detected or likely to be present in wastewater from each pesticide process. The process chemistry for each of the 280 pesticide products in the scope of this study was evaluated in Section V to determine what combinations of priority pollutants have been detected or are likely to be present in its wastewaters. The treatment recommended to remove conventional, nonconventional, and priority pollutants was evaluated in Section VI as to technical feasibility and performance. Based on treatability of the priority pollutants detected or likely to be present, the major treatment units recommended are chemical oxidation, steam stripping, metals separation, pesticide removal (adsorption or hydrolysis), and biological oxidation. Seven combinations of these units provide for removal of the priority pollutants detected or likely to be present in the pesticide industry, and therefore based on the presence of pollutants detected or likely to be present and treatability, seven subcategories were initially proposed.

Some pesticides with identical wastewater treatability have been separated into more than one subcategory because of differences in prior regulatory status. For example, 2,4-D, which was previously regulated in BPT for conventional and nonconventional parameters, was placed in Subcategory 9. Whereas, 2,4-DB, which was not previously regulated in BPT, was placed in Subcategory 2. Both Subcategories 2 and 9 include steam stripping, pesticide removal, and biological oxidation as recommended treatment units. This factor increased the number of proposed subcategories from 7 to 17.

Raw waste and treated effluent priority pollutant concentrations were examined and compared to the design effluent levels shown in

Sections XII and XIV. Design effluent levels are long-term average effluent levels demonstrated or judged achievable from maximum design raw waste load levels. This evaluation process is depicted in Figure VII-1 and ultimately defines the treatment alternative best suited to remove pollutants found in concentrations above the design levels. Treated effluent levels for BOD, COD, and TSS were evaluated in relation to levels regulated in BPT. Pesticides that are meeting or were considered able to meet BPT, BOD, COD, and TSS pollutant levels were grouped together. These evaluations reduced the number of proposed subcategories from 17 to 10.

Some pesticide manufacturing processes achieve no discharge of wastewater through total reuse, recycle, evaporation, incineration without scrubber effluent, or because no wastewater is generated. Based on industry 308 Survey responses, 29 pesticides were found which fit this definition. This factor created the proposal for an eleventh subcategory.

The need to address regulation of the formulating/packaging processes and metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products not previously regulated during BPT created the recommendation for a twelfth and thirteenth subcategory.

Plant location, age, and size were examined and found not to be factors in subcategorization. A detailed discussion of all the factors considered in subcategorization is presented below.

Raw Materials

The particular combination of raw materials used in the industry is unique to individual products, although as discussed in Section V many products share the same raw material. When these raw materials are priority pollutants, or when they contain impurities which are priority pollutants, then raw materials become a significant factor in subcategorization. As reported by Plant 1 in March 1977, typical pesticide manufacturing reactions are only 75 to 94 percent complete; therefore, the source of priority pollutants in wastewaters can often be traced to unreacted raw materials or their impurities.

It was necessary to inventory the raw materials utilized in each of the 280 pesticides in the scope of this study, based on proprietary information provided by manufacturers in their responses to the industry 308 Survey and based on an independent review of process chemistry by EPA and its contractor. In this manner a matrix was developed, as shown in Section V, which identified all pesticides with wastewaters which when detected or when likely to be present contained the same combination of specific groups of priority pollutants. Pesticides with similar priority pollutants were placed in the same subcategory for further evaluation.

As reported by several manufacturers such as Plant 2, even the same raw material purchased from different suppliers can contain altogether

different levels of priority pollutant impurities. Since raw materials specifications were not received from manufacturers, then differences due to this factor must be identified on a case-by-case basis and are therefore not a determining factor in subcategorization. Raw materials differences should be further evaluated to determine if differences in wastewater characteristics subsequently exist. Manufacturers can and have requested suppliers to provide raw materials of different purity, thereby eliminating or reducing the priority pollutants present. For example, users of 2,4,5-trichlorophenol have requested suppliers to reduce TCDD to below detection limits.

Wastewater Treatability

The treatability of each priority pollutant or group of pollutants was examined to determine the most feasible treatment alternative and its corresponding cost. Each of the unit treatment processes so considered has been discussed in Section VI.

A matrix was developed, as shown in Table VI-22, to evaluate the selection of one or more technologies for each pollutant group. Based on an examination of actual treatment utilized, treatability studies conducted in the industry and treatability data from other industries, as discussed in Section VI, those technologies found to be effective and economically achievable have been recommended and costed for each subcategory. In addition, the treatment units were costed on a plant-by-plant basis.

Once the treatability for specific pollutants or groups of pollutants had been determined, this information was coupled with evaluations detailing which priority pollutants or groups of pollutants are generated by each of the 280 pesticides as defined by the raw materials analysis in Section V. Raw materials and treatability matrices were combined to determine the recommended treatment units for each individual pesticide in the industry. All the pesticides sharing common treatment recommendations were then placed in one subcategory (for example, each pesticide with wastewaters containing phenols, volatiles, and traditional pollutants detected or likely to be present was placed in a category where adsorption, steam stripping, and biological oxidation, respectively, were recommended).

Due to the diversity in the nature of wastes encountered in the industry, more than one technology alternative has been recommended within individual subcategories. For example, based on treatability studies conducted for each individual pesticide wastewater, it may be determined that removal of the pesticide active ingredient is most efficiently performed in either hydrolysis, resin adsorption, or carbon adsorption systems. Since these solutions to pesticide removal were demonstrated in the BPT regulation to be typical for the industry, all three have also been recommended and costed in BAT for purposes of comparison. Individual plants may elect to achieve effluent levels by any type of in-process or end-of-line treatment rather than the specific treatment units described in this report. The type of treatment

alternative chosen for pesticide active ingredient removal is therefore not a factor in subcategorization.

For certain processes in the industry, a portion of the wastestream may contain refractory wastes which cannot be effectively or economically treated by conventional end-of-pipe technologies (for example, distillation tars, solvent bleed streams, stripper overheads which cannot be recycled, and concentrated organic residues). Since these processes are distributed throughout the industry in a manner unrelated to specific priority pollutant groups or treatability, alternative methods of disposal, such as incineration, evaporation, and contract hauling, have been designed and costed for each subcategory. These refractory waste streams, when they represent only a portion of the total wastewater from a particular process, are therefore not a factor in subcategorization. When all process wastewater from a pesticide is incinerated, and a scrubber effluent discharge is present, it is predicted that priority pollutants and nonpriority pollutant pesticides will be destroyed in the incinerator. Six pesticides (captafol, fenarimol, isopropalin, oryzalin, tebuthiuron, and tricyclazole) fall under this classification, and it is therefore assumed that no priority pollutant or pesticide treatment is required for the scrubber effluent. In this case, then, treatability of all process wastewaters by incineration is a factor in subcategorization.

Prior Regulatory Status

The status of previous regulations affects subcategorization because different pollutants must be regulated for different groups of pesticides. These groups are summarized below:

1. Pesticides previously excluded from BPT regulations--must be regulated in expanded BPT for COD, BOD, TSS, and pH, and in BAT for nonconventional pesticides and priority pollutants.

2. Pesticides previously regulated in BPT for BOD, COD, TSS, and pH--must be regulated in BAT for nonconventional pesticides and priority pollutants.

3. Pesticides previously regulated in BPT for BOD, COD, TSS, pesticides, and pH--must be regulated in BAT for priority pollutants.

The effect this had on subcategorization was that the seven subcategories initially created because of wastewater pollutants/treatability were expanded because of prior regulatory status into 17 subcategories.

Wastewater Characteristics

Data on flow, pollutant concentration, and ratio of pollutant to production were collected for 280 pesticides as pertains to the

126 priority pollutants as well as BOD, COD, TSS, and pesticides. For each pesticide these data were combined with indicated raw material, raw material impurity, and reaction byproduct pollutant information as defined by the process evaluation presented in Section V. Once the priority pollutants detected and likely to be present in each pesticide process were defined, and the treatability and regulatory status considered, the level of pollutant concentration became a limiting factor in determining subcategorization.

The evaluation sequence shown in Figure VII-1 was used to determine treatment recommendations for each pesticide based on level of wastewater pollutant concentration. Raw waste and treated effluent priority pollutant data for each pesticide were evaluated and compared to the design effluent levels in order to arrive at one of the three following conclusions:

1. Treatment for the specific priority pollutants is recommended because current effluents do not meet design levels.

2. Treatment for the specific priority pollutants is recommended, but will not be costed in subsequent plant-by-plant economic impact analyses. This indicates that the pesticide should be placed in a subcategory where the specific priority pollutant is monitored, but that it is currently meeting design levels.

3. No treatment for the specific priority pollutant is recommended because the raw waste load concentration is less than the design level.

Data for the pollutants BOD, COD, and TSS were also evaluated to determine if treated effluents could meet levels regulated in BPT.

The effect the wastewater characteristics analysis had on subcategorization was to reduce the number of proposed subcategories from 17 to 10, as shown in Table VII-1.

In addition to the above-mentioned criteria, the nonpriority pollutant ammonia, when likely to be present in pesticide process wastewater, placed that pesticide in a subcategory where steam stripping was recommended. This subcategory assignment simply recognizes that ammonia is commonly treated by steam stripping in the industry.

One facet of the proposed subcategorization scheme should be highlighted. If no raw waste load or treated effluent data are available, but a pesticide is likely to contain a priority pollutant from the process chemistry evaluation, the pesticide has been placed in a category which provides treatment for removal of the priority pollutant. Future monitoring may show that the levels of the pollutant do not justify the recommendation of a specific technology for its removal.

For example, a raw waste load phenol level of 10 mg/l would not require a carbon column for removal if it could be degraded to the design level in a subsequent biological process. In certain cases, therefore, current judgments of recommended treatment will be an overestimate of actual requirements to meet design levels.

In subcategories with similar pollutants/technology, the flows, pollutant concentrations, and ratios of pollutant to production may vary considerably. This fact is not judged to be a requirement for further subcategorization at this time. Treatment designs and cost estimates are provided to accommodate the maximum levels in each category; therefore, lower wastewater characteristics can only result in smaller economic impact. Contract hauling and evaporation are recommended as treatment alternatives where flows are 0-1,000 gpd and 1,000-5,000 gpd, respectively.

Based on manufacturers' responses to a 308 Survey and follow-up responses, a list of 22 pesticides was developed for which no discharge of process wastewaters exists because of total reuse, recycle, or because no wastewater is generated. Due to these wastewater characteristics, an eleventh subcategory was created for pesticides that achieve "zero discharge."

Method of Disposal

Several methods of disposal which are utilized in the industry effectively eliminate the discharge of wastewater to navigable waters or publicly owned treatment works. When all wastewater from a pesticide process was found to be disposed by evaporation or incineration without scrubber effluent, then the pesticide was placed in the eleventh "zero discharge" subcategory. Therefore only evaporation and incineration without scrubber discharge, as methods of disposal, are a basis for subcategorization.

Manufacturing Processes

Pesticide manufacturers are known to utilize as few as one and as many as eight unit operations, as reported by Plant 3, in the production of active ingredients. Based on manufacturers' responses to the 308 Survey, the principal unit operations utilized were determined to be chemical synthesis, separation, recovery, purification, and product finishing, such as drying. Chemical synthesis can include chlorination, alkylation, nitration, and many other substitution reactions. Separation processes include filtration, decantation, extraction, evaporation, distillation, stripping, and centrifugation. Recovery and purification steps are utilized to reclaim solvents for excess reactants as well as to purify final products.

The number or type of unit operations is not in itself a determining factor in subcategorization, however several specific operations are known to favor the generation of priority pollutants. For example, the

amination of compounds such as halogenated alkylbenzenes yields secondary amines; these secondary amines are known to produce priority pollutant nitrosamines upon nitration. The chlorination of various raw materials generates priority pollutant chlorophenols, chlorobenzenes, hexachlorocyclopentadienes, and TCDD.

Batch, semicontinuous, and continuous processes have been examined for their relationship to potential subcategorization. Equalization of process wastewater has been shown by 43 plants to negate any differences in treatability among the three types of processes. This fact was demonstrated in BPT as regards the conventional pollutants BOD and TSS; nonconventional pollutant COD; and 49 pesticide active ingredients. Since equalization is a recommended treatment for all subcategories, the type of process does not in itself create the demand for additional subcategories.

Several manufacturers of identical products use fundamentally different processes. For example, Pesticide A is produced by both solvent and water-based reactions, thereby creating volatile organic priority pollutants in process wastewaters from one product but not the other. This is an obvious example where manufacturing processes influence wastewater characteristics; however, the treatability of the two wastewaters must be examined first before it can be assumed that the difference in processes creates a demand for different subcategories. The use of different processes for the same product is the exception rather than the rule in the pesticide industry.

Metallo-Organic Manufacturing Processes

Direct discharge metallo-organic manufacturers were regulated under BPT as a separate subcategory with the state-of-the-art such that no discharge of process wastewater pollutants was being achieved through the application of recycle technology. Based on available information it is believed that metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products can achieve or are achieving zero discharge through wastewater recycle or reuse. Therefore, based on manufacturing process, it is proposed that existing metallo-organic manufacturers which discharge wastewater to municipal treatment plants and new direct and indirect discharge metallo-organic manufacturers be assigned to a twelfth subcategory.

Formulating/Packaging Processes

Adequate information is available to regulate the formulator/packager segment of the pesticide industry, based on data for the direct discharge formulator/packagers which were regulated as a separate subcategory under BPT. The data collected to support this regulation show that approximately 90 percent of the formulator/packagers surveyed do not generate any process wastewater. The remaining plants in that data base generate such small volumes that disposal can be handled adequately and more inexpensively by disposal contractors, land application, evaporation, or other means leading to no discharge of

process wastewater pollutants. It is assumed that the data base is representative of the formulator/packagers subcategory. In addition, formulator/packagers conduct the same types of operations regardless of mode of discharge; thus, it is reasonable to assume that the indirect discharger formulator/packagers can achieve the same limitations and standards as the direct formulator/packagers. Therefore, it is proposed that existing pesticide formulator/packagers which discharge wastewater to municipal treatment plants or navigable waters and new direct and indirect discharge formulator/packagers be assigned to a thirteenth subcategory.

Plant Location

Plant location has no observed effect on the quality or quantity of wastewater generated, assuming that pollutant mass loadings are calculated on a net basis so as to exclude the contribution of pollutants in the intake water. Geographic location, however, can influence the performance of aerated and stabilization lagoons. In these cases, performance problems can be overcome by adequate sizing, proper equalization, or selection of alternative treatment processes, such as activated sludge.

Plant location can affect the availability and cost of land required for the installation of pollution control facilities. As part of the 308 Survey response, it was determined that land prices varied between $200 and $200,000 per acre. For the purposes of cost estimates an average cost of $30,000 per acre has been utilized. Neither extremes of land cost could cause total treatment costs to vary enough to demand that another subcategory be created. The cost differential can only be determined on an individual case basis once additional land requirements, if any, are known.

Plant Age

Pesticide plants are relatively new, being commissioned predominantly since post-World War II. Because pesticide manufacturing plants are modified as needed for individual product or process changes, plant age does not necessarily reflect the type or efficiency of process technology employed. Plant wastewater sewer piping systems sometimes lag behind process equipment in modernization, making it difficult to segregate wastewaters for economy of treatment. In such cases oversized treatment systems are often designed in order to compensate for inefficient piping. On the other hand, most plants built or upgraded within the last six to seven years have had considerably more effort devoted to process and treatment controls related to wastewater pollution. This effort is due, in part, to implementation of the National Pollutant Discharge Elimination System (NPDES) permit program. Consequently, these plants may generate lower-volume, lower-strength wastewater resulting in less costly pollution control technology. The general trend has been toward upgrading plants, rather than seeking permit approval for new sites.

The effect of plant age must be evaluated on an individual site basis, as its advantages or disadvantages can be overshadowed by factors such as type, level, and source of pollutant as well as method of treatment required. For these reasons it is concluded that plant age is not a significant factor for subcategorization.

Plant Size

As noted in Section IV, total plant production is usually the sum of from one to four different pesticides. It was further noted that 46.8 percent of plants in the industry were categorized in the lowest of five production level groups. When plant size is compared to the installation cost of pollution control equipment, the effect is not advantageous to small manufacturers. According to Jelen (1970), the size of treatment systems is normally related to cost by the 0.6 factor (i.e., a plant with a flow 10 times that of a smaller plant would only require $(10/1)^{0.6} = 3.98$ times more capital), the economic impact of high initial capital cost technology may be more strongly felt by the small plant. Plant size does not, however, dictate the type or strength of pollutant, nor the treatment required. It is therefore concluded that plant size is not a determining factor in subcategorization because it does not relate to treatability; plant size should be examined closely, however, as it relates to economic impact at individual facilities.

Pesticides Previously Regulated But Currently Not Manufactured

Of the 24 pesticides currently not manufactured that were previously regulated for pesticide, BOD, COD, and TSS parameters according to BPT regulations, 22 have been included in the current subcategorization. The remaining two, aldrin and dieldrin, have been banned by EPA from manufacture and use. If these pesticides currently not manufactured are reactivated and production begins, then they will be required to meet the applicable regulations according to the subcategory in which they fall.

Pesticides Previously Excluded From BPT Regulations But Currently Not Manufactured

Of the 14 pesticides currently not manufactured that were previously excluded from BPT regulation for all parameters, 10 have been included in the current subcategorization. Three have been excluded from the scope of this study: gibberellic acid and naphthalene acetic acid have been classified as plant growth regulators and excluded from the BAT scope, and the manufactured product dimethyl phthalate would be regulated in another industrial category. Bisethylxanthogen has been identified as EXD which is included in the study. If these ten pesticides currently not manufactured are reactivated and production begins, then they will be required to meet the applicable regulations according to the subcategory in which they fall.

PROPOSED SUBCATEGORIZATION

After considering each of the factors affecting subcategorization, in particular, raw materials, treatability, prior regulatory status, and wastewater characteristics, ten subcategories were developed as outlined in Table VII-1. Placement in a subcategory shows that the pesticide wastewater contains priority pollutants detected or likely to be present which can effectively be removed by the recommended combination of treatment units.

Products Included

Table VII-2 itemizes the pesticides included in each subcategory. Plant numbers after a pesticide name indicate which of several manufacturers is to be regulated in the subcategory. If no plant numbers appear following a pesticide name, the subcategorization applies to all manufacturers of those pesticides listed.

Zero-Discharge Pesticides

Pesticides which generate no wastewater, or whose wastewater is not discharged because of recycle, reuse, evaporation, or incineration without scrubber discharge, were placed in Subcategory 11 as shown in Table VII-3. These 29 pesticides have been shown to achieve no discharge of process wastewater to either POTW or navigable waters.

Metallo-Organic Pesticide Manufacturers

Metallo-organic pesticide manufacturers of mercury, copper, cadmium, and arsenic-based products were placed in Subcategory 12, as shown in Table VII-4. These metallo-organic manufacturers are proposed for regulation if not previously regulated under BPT for existing direct discharge. Therefore, new and existing indirect dischargers and new direct dischargers of metallo-organic pesticides will be regulated.

Formulating/Packaging of Pesticides

Formulated and/or packaged pesticide active ingredients were placed in Subcategory 13, as shown in Table VII-5. New and existing indirect discharger and new direct discharger formulator/packagers will be regulated.

Table VII-1. Subcategory Numbering System

Treatment Units Recommended	Subcategory Numbering According to Parameters Previously Regulated/ Wastewater Characteristics		
	BOD, COD TSS, pH	BOD, COD, TSS pH, Pesticides	None
Pesticide Removal Biological Oxidation	1	8	--
Steam Stripping Pesticide Removal Biological Oxidation	2	9	--
Metals Separation Pesticide Removal Biological Oxidation	3	--	--
Steam Stripping Chemical Oxidation Pesticide Removal Biological Oxidation	4	--	10
Steam Stripping Metals Separation Pesticide Removal Biological Oxidation	5	--	--
Chemical Oxidation Pesticide Removal Biological Oxidation	6	--	--
Steam Stripping Chemical Oxidation Metals Separation Pesticide Removal Biological Oxidation	7	--	--

-- = Combination is not required based on the observed data.

Table VII-2. Products Included in Each Subcategory

Subcategory 1
Pesticides Included: 64

Aldicarb	HAMP
Atrazine (Plant 1)*	Isopropalin
Bendiocarb	KN methyl
Benomyl	Maleic hydrazide
Benzyl benzoate*	Metham
Biphenyl (Plant 2)*	Methoprene*
Busan 40	Mevinphos
Busan 85	1,8-Napthalic anhydride*
Captafol	Niacide
Carbam-S	Norflurazon
Carbofuran	Octhilinone
Chloropicrin (Plant 3)	Oryzalin
Coumachlor*	Oxamyl
Coumafuryl*	PCP salt
Coumaphos	Permethrin
Coumatetralyl*	Phorate
Dalapon	Piperonyl butoxide*
Dazomet	Polyphase antimildew
DBCP	Propargite*
Dichlorvos	Propionic acid
Dimethoxane	8 Quinolinol citrate
Dinocap	8 Quinolinol sulfate
Dinoseb	Sodium monofluoroacetate (Plant 4)
Dioxathion	Sulfallate
Diphacinone*	Tebuthiuron
Endothall*	Terbacil
Ethylene dibromide	Terbufos
EXD*	Thionazin
Fenarimol	Tributyltin fluoride
Ferbam	Tricyclazole
Folpet	Vancide PA
HAE	Warfarin*

* Previously excluded from BPT regulation.

Table VII-2. Products Included in Each Subcategory
(Continued, Page 2 of 6)

Subcategory 2
Pesticides Included: 113

Alachlor	Dichlorobenzene, ortho
Allethrin*	Dichlorobenzene, para
AOP†	Dichlorophen
Aspon	Dichlorprop
Benfluralin	Diphenamid
Bensulide	Diphenylamine
Bentazon	EPN
Benzethonium chloride	EPTC
Benzylbromoacetate	Ethalfluralin
Bifenox	Ethion
Bolstar	Ethoxyquin, 66%
Bromacil	Ethoxyquin, 86%
Bromoxynil	Etridiazole
Bromoxynil octanoate	Famphur
Busan 90	Fenthion
Butachlor	Fentin hydroxide
Butylate	Fluchloralin
Carbendazim†	Fluoridone
Carbophenothion	Fonofos
CDN	Giv-gard
Chlorambent†	Glyphosate*
Chlorobenzene	Hexachlorophene
Chlorobenzilate	Hexazinone*
Chlorophacinone*	Hyamine 2389
Chlorpyrifos	Hyamine 3500
Chlorpyrifos methyl	Kathon 886
Cycloate	Kinoprene†
Cycloheximide	MCPA
Cycloprate	MCPA isooctyl ester†
Cyhexatin	MCPP
Cythioate	Mephosfolan
2,4-D isobutyl ester†	Methamidophos
2,4-D isooctyl ester† (Plant 5)	Methomyl
2,4-DB	Methylbenzethonium chloride
2,4-DB isobutyl ester†	Methyl bromide
2,4-DB isooctyl ester†	MGK 264
DCPA	MGK 326
Deet	Molinate
Demeton	Nabam†
Dichlofenthion	

* Previously excluded from BPT regulation.

† Presence of nonpriority pollutant ammonia determined that this pesticide be placed in a subcategory which included stripping.

Table VII-2. Products Included in Each Subcategory
(Continued, Page 3 of 6)

Subcategory 2 (Continued)

Naled	Pronamide
Napropamide	Propachlor
Naptalam	Propanil
Nitrofen	Quinomethionate*
NMI	RH-787
Oxydemeton	Ronnel
Oxyfluorofen	Rotenone*
Paraquat	Stirofos
PBED	Sulfoxide*
PCP	Temephos
Phenylphenol*	Thiofanox†
Phenylphenol sodium salt*	Tokuthion
Phosfolan	Triadimefon
Phosmet	Tributyltin oxide (Plant 5)
Pindone	Trichlorobenzene
Piperalin	Trichloronate
Profluralin	Vernolate

* Previously excluded from BPT regulation.

† Presence of nonpriority pollutant ammonia determined that this pesticide be placed in a subcategory which included stripping.

Subcategory 3
Pesticides Included: 5

Aquatreat DNM 30
Mancozeb
Maneb
Zineb (Plant 6)
Ziram (Plants 7, 8)

Subcategory 4
Pesticides Included: 6

Chlorothalonil
Fluometuron
Lethane 384
Methylene bisthiocyanate
Picloram
Thiabendazole

Table VII-2. Products Included in Each Subcategory
(Continued, Page 4 of 6)

Subcategory 5 Pesticides Included: 7
Acephate
Dienochlor
Fensulfothion
Monocrotophos
Pebulate
ZAC†
Zineb† (Plant 10)

† Presence of nonpriority pollutant ammonia determined that this pesticide be placed in a subcategory which included stripping.

Subcategory 6 Pesticides Included: 3
Dodine
Metasol DGH
Nabonate

Subcategory 7 Pesticides Included: 2
Fenitrothion
TCMTB

Subcategory 8 Pesticides Included: 14
Aminocarb
Chlordane
Endosulfan
Fenuron
Malathion
Methiocarb
Mexacarbate
Mirex
Monuron
Parathion ethyl
Parathion methyl
Propham
Propoxur
Trifluralin

Table VII-2. Products Included in Each Subcategory
(Continued, Page 5 of 6)

Subcategory 9
Pesticides Included: 32

Azinphos methyl
BHC (Alpha, Beta, and Delta isomers)
Captan*
Carbaryl
Chlorpropham
2,4-D
DCNA
DDD
DDE
DDT
Demeton-o
Demeton-s
Diazinon
Dicamba
Dicofol
Disulfoton
Diuron
Endrin
Fenuron-TCA
Heptachlor
Lindane
Linuron
Methoxychlor
Monuron-TCA
Neburon
PCNB
Perthane
Siduron
Silvex
SWEP
2,4,5-T
Toxaphene

* Presence of nonpriority pollutant ammonia determined that this pesticide be placed in a subcategory which included stripping.

Table VII-2. Products Included in Each Subcategory
(Continued, Page 6 of 6)

Subcategory 10 Pesticides Included: 13
Ametryne*
Anilazine*
Atrazine (Plants 11, 12)*
Cyanazine*†
Metribuzin*
Prometon*
Prometryn*
Propazine*
Resmethrin*
Simazine*
Simetryne*
Terbuthylazine*
Terbutryn*

* Previously excluded from BPT regulation.

† Presence of nonpriority pollutant ammonia determined that this pesticide be placed in a subcategory which included stripping.

Table VII-3. Zero-Discharge Pesticides

Subcategory 11
Pesticides Included: 29

The following pesticides are assigned a zero-discharge status because wastewater is totally recycled, reused, evaporated, incinerated, or because there is no wastewater generated:

Alkylamine hydrochloride
Amobam
Barban
BBTAC
Biphenyl* (Plant 13)
Chloropicrin (Plants 14, 15, 16)
2,4-D isooctyl ester (Plant 17)
2,4-D salt
D-D
Dichloroethyl ether
Dichlorophen salt
Dichloropropene
Dowicil 75
Ethoprop
Fluoroacetamide
Glyodin
HPTMS
Merphos
Metasol J-26
Pyrethrin
Silvex isooctyl ester
Silvex salt
Sodium monofluoroacetate (Plant 18)
Tributyltin benzoate
Tributyltin oxide (Plant 19)
Vancide 51Z
Vancide 51Z dispersion
Vancide TH*
Ziram (Plant 20)

* Previously excluded from BPT regulation.

Table VII-4. Metallo-Organic Pesticide Manufacturers of Mercury, Cadmium, Copper, and Arsenic-Based Products

Subcategory 12
All new and existing indirect discharge and direct discharge metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products are assigned a zero-discharge status.

Table VII-5. Formulator/Packagers

Subcategory 13
All new and existing indirect discharge and direct discharge formulator/packagers of pesticide active ingredients are assigned a zero-discharge status.

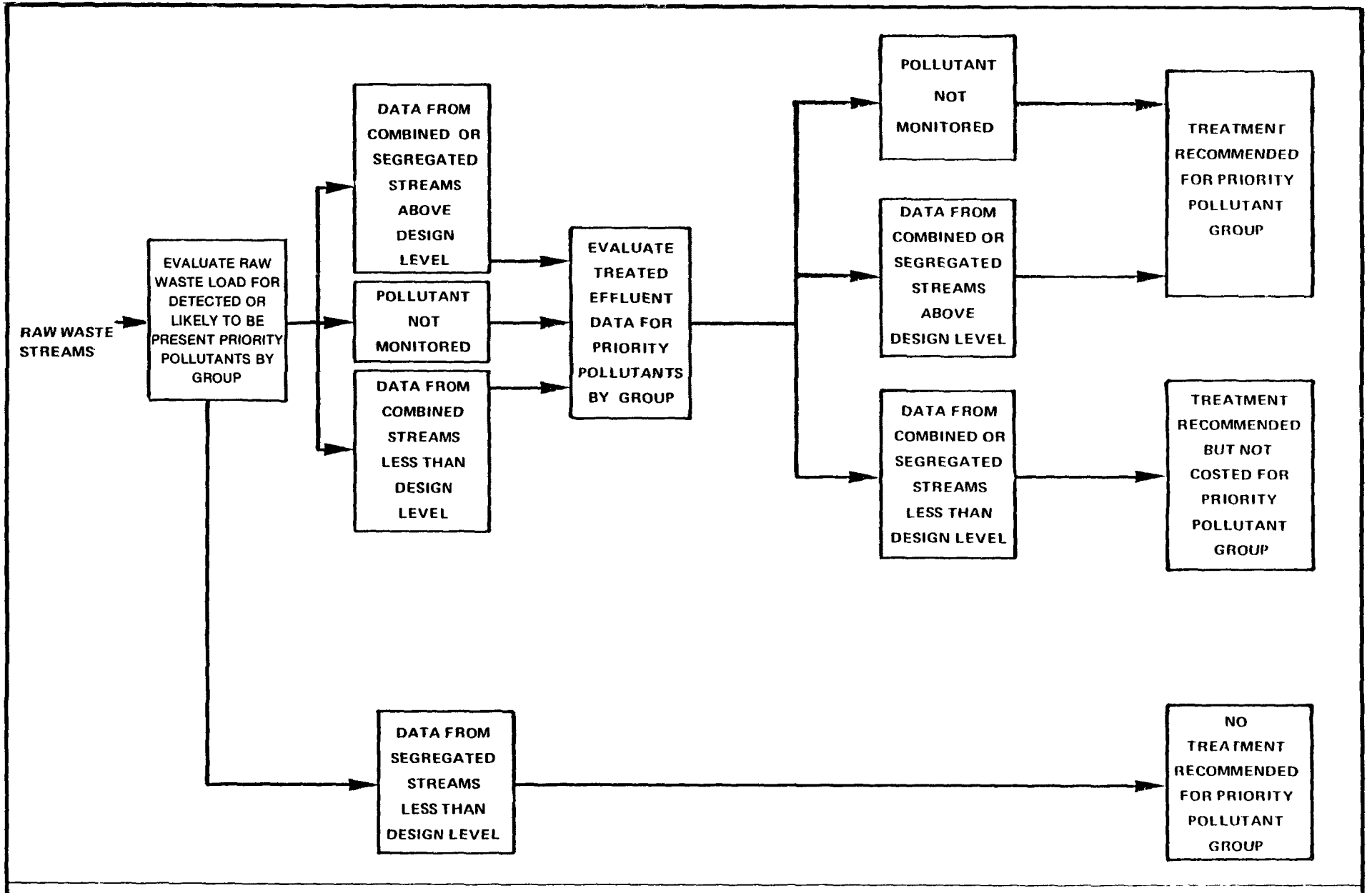


Figure VII-1 DECISION FLOW CHART FOR EVALUATION AND SUBCATEGORIZATION OF PESTICIDES BASED ON WASTEWATER CHARACTERISTICS

SECTION VIII

COST, ENERGY, AND NONWATER QUALITY ASPECTS

The purpose of this section is to document the cost, energy, and nonwater quality aspects of recommended treatment technology presented in Section VII.

COST AND ENERGY

The costs presented in this section are estimates of the capital, annual, and energy expenses which could potentially be incurred to meet the design effluent levels presented in Sections XII and XIV. The costs itemized are based on the assumption that plants already have installed pesticide removal and/or biological oxidation systems where BPT regulations require. These estimates are therefore the incremental costs above and beyond BPT. The costs presented here represent the maximum expenditures which would be required to treat detected and likely to be present priority, conventional, and nonconventional pollutants. For example, it was shown in Table V-10 that 34 pesticides have the potential for phenolic priority pollutants to be present in their wastestreams. Of those pesticides for which data were available, only 10 pesticides, or 29 percent, contained phenols over the level of 100 mg/l. Adsorption technology has been designed and costed which would reduce that 100 mg/l of phenol to 1 mg/l, however, it is estimated at this time that 69 percent of the pesticides may not require such stringent control nor will they incur the maximum costs that are derived.

The Agency does not require that these technologies be installed at any plant location; however, the application of these technologies will attain the design effluent levels. Individual plants have the option of utilizing process modifications, in-plant controls, alternate methods of disposal, alternate end-of-pipe treatment units, or any combination of the above in order to achieve equivalent effluent levels. A plant-by-plant cost analysis has been conducted in order to allow a separate economic contractor to assess the potential impact of installing the recommended treatment to meet design effluent levels. This analysis is presented in Sections XII and XIV.

The cost estimates in this section are presented on a subcategory, rather than plant-by-plant, basis. They show the range of costs potentially incurred by model plants of various flows and differing pesticide treatability. They were derived in the following manner:

1. Costs were generated for each treatment unit specified in Section VI based on September 1979 dollars and corresponding to a Marshall and Swift Index value of 630. The capital and annual cost assumptions for these computations

are presented in Tables VIII-1 and VIII-2. The basis for these assumptions is documented in the Administrative Record to the proposed regulations. The total construction costs for each unit were prepared from equipment manufacturers' estimates which were compared to actual plant data when available. The total construction costs include the treatment unit cost, land, electrical, piping, instrumentation, site preparation, engineering, and contingency fees. Annual and energy costs were calculated in accordance with the assumptions specified. Cost curves were prepared for dollars versus volume treated, and each of the components included in the individual treatment units was specified. These cost curves are presented graphically in Figures VIII-1 through VIII-21.

2. The total cost for each subcategory, as summarized in Tables VIII-3 through VIII-5, was derived by summing the costs for individual treatment units that are specified for each level of control recommended in Sections XII and XIV. Treatment costs for each subcategory are based on flow rates of 0.01 MGD, 0.1 MGD, and 1 MGD for pesticide manufacturers which were representative of actual flows in the industry; flows below 0.01 MGD were provided with alternative costs for evaporation or contract hauling as is practiced in the industry. Treatment costs for zero dischargers, metallo-organic pesticide manufacturers, and pesticide formulator/packagers, Subcategories 11, 12, and 13, respectively, are based on representative flow rates of 50 gpd, 500 gpd, and 5,000 gpd.

3. For pesticide manufacturers, a high and low cost for each treatment unit was introduced to reflect differences in degree of treatability or differences in recoveries obtainable. For example, in each case where pesticide removal was recommended, the costs for activated carbon, resin adsorption, and hydrolysis were compared. The effectiveness of these technologies has been demonstrated within the design ranges provided; however, each individual pesticide plant must determine by laboratory and/or pilot scale treatability studies the exact design criteria to meet effluent objectives. In general, this comparison resulted in the selection of carbon adsorption at 750 minutes detention time for the high cost, and hydrolysis at 400 minutes detention time for the low cost for each subcategory. In this cost comparison, 12-hour equalization, neutralization, dual media filtration, and pumping stations were assumed to be part of both activated carbon and resin adsorption systems.

   High and low costs were also provided where steam stripping was the designated technology to account for the

fact that stripped organics may either be returned to the process (in which case a recovery has been calculated) or that they become a wastestream which is normally disposed by incineration.

High and low costs have been provided for the incineration unit to reflect the fact that the size of the unit and especially the annual costs are quite different depending on whether a chlorinated hydrocarbon or aqueous oily waste is being disposed. A reduction of fuel consumption based on the fuel value of hydrocarbon wastestreams has been considered.

A high and low cost has been provided for evaporation ponds, corresponding to solar evaporation and spray evaporation alternatives which are determined by site-specific climatic conditions.

The high and low costs for annual and energy may appear reversed. This simply means that the annual cost for a high capital system may be less than the annual cost for a low capital system.

4. The flows upon which unit treatment costs are based have been split into three groups based on wastewater segregation. Wastestreams not compatible with biological treatment (i.e., distillation tower bottoms, stripper overhead streams, reactor vent streams, etc.) are most effectively disposed of by incineration. Based on the operating range of incinerators in the industry it has been assumed that 1 percent of the total flow from the plant requires incineration. This corresponds to a range of 100 to 10,000 gallons per day.

   Based on the actual operating practices in the industry, steam stripping, chemical oxidation, and metal separation have been costed at flows equal to one-third the total volume disposed by the plant for total flow rates of 0.1 MGD and 1 MGD. Flow rates of 0.01 MGD have been costed at full flow. Pesticide removal (hydrolysis, activated carbon, or resin adsorption) and biological treatment (equalization, neutralization, nutrient addition, aeration basin, etc.) have been costed based on the total flow.

5. The high and low costs for each subcategory and each level of technology are summarized in Tables VIII-3 through VIII-5 for capital, annual, and energy estimates. Table VIII-3 shows that the capital costs for Level 1 technology, excluding evaporation or contract hauling, are a minimum of $290,000 and a maximum of $4,690,000 at a flow rate of 0.1 MGD for pesticide manufacturers

(Subcategories 1 through 12); Level 3 technology is shown to cost a minimum of $854,000 and a maximum of $5,250,000. There are four subcategories (6, 11, 12, and 13) where the average flow was less than 10,000 gallons per day for which it may be more cost-effective to dispose of wastes by contract hauling or evaporation, than to construct a wastewater treatment plant.

Cost itemization for each treatment unit in each subcategory is presented in Tables VIII-6 through VIII-27, including costs for alternative disposal by evaporation ponds or contract hauling.

NONWATER QUALITY ASPECTS

An analysis of the total nonwater quality aspects of the manufacturing and formulating/packaging of pesticides is beyond the scope of this study. Instead, the discussion of the potential contamination by gaseous, liquid, and solid wastes will be restricted to those areas directly affected by the implementation of technology recommendations contained in this report.

Air Quality

Incineration has been recommended as a means for disposing of concentrated organic liquids and nonrecoverable solvents. The incinerator design recommended in this study provides for the scrubbing of off-gases with caustic or lime, should there be hydrogen chloride gas present, or with water in cases where nonchlorinated liquid wastes are being fed to the incinerator. Given the proper temperature and dwell time in the combustion chamber, greater than 99.9 percent removal of pesticide active ingredients can be maintained so that a potential air pollution problem is not created. Nitrogen-based pesticides could generate cyanide gas if incineration temperatures and excess air are not adequate, and this potential should be monitored for specific wastestreams. Incineration is not applicable to organic pesticides containing heavy metals such as mercury, lead, cadmium, arsenic, copper, or zinc.

Air stripping of volatile organics from biological oxidation systems has generally been assumed to be a potential air pollution problem. This conclusion should be substantiated before technology recommendations in this study are implemented. For example, steam stripping of volatile organics which are detected or likely to be present has been provided as a pretreatment step before biological oxidation, in order to remove volatile organics to approximately one part per million. This stripping has been designed to remove volatiles such as methylene chloride at a maximum rate of 167,000 pounds per MGD, or an annual cost of $0.0279 per pound methylene chloride per MGD. This removes the potential release of the compound from a biological system to the atmosphere in return for the capital and annual expenses associated with the stream stripper.

The air stripping thesis appeared to be verified in a study by Coco (1978) who analyzed 18 separate chlorinated solvent process streams. In each case the sample was analyzed, aerated for 500 minutes, and analyzed again, in order to simulate a bio-aeration system. Removal of aromatic solvents and chlorinated ethanes ranged from 88.6 percent to 99.9 percent.

In an evaluation of the potential air stripping of hydrocarbons during activated sludge wastewater treatment, Engineering Science (1979) contends that biological removal of hydrocarbon compounds greatly exceeds the removal by air stripping of the volatile components in the presence of activated sludge biomass. Engineering Science reports that less than 0.5 percent of the raw wastewater TOC was air stripped when as much as 21 percent contained the potential for stripping. In monitoring the hydrocarbon content of the air with a Bendix Model 8202 reactive analyzer it was concluded that any predicted methodology for estimating hydrocarbon emissions substantially overestimates this potential air pollutant source.

Both solar and spray evaporation have been recommended as alternative methods for disposal of low volumes of wastewater. Although the potential for evaporation of volatiles and possible losses by drift have not been quantified at this time, the State of Texas has determined that methanol and less volatile arsenic emissions from a pesticide wastewater evaporation pond would be below the level of significance (U.S. Court of Appeals for the First Circuit, 1979).

On-site regeneration of activated carbon has been recommended as an alternative for the removal of pesticides, phenols, nitrosamines, and chlorinated dienes. The furnace which is utilized in this system has been provided with an afterburner to control obnoxious gases and a wet scrubber for dust collection and cooling of gases.

In a study conducted by Wagner, et al. (1979) it was determined that the conditions necessary to safely incinerate granular activated carbon reactivation off-gases were within the normal operating range of a typical afterburner. Of the eight compounds selected five were not present in their original form in the furnace off-gases (two of these five were the pesticides malathion and 2,4-D). The residual levels of the other three compounds, and the hydrocarbon decomposition products from all eight compounds, were reduced by at least 98 percent in the afterburner.

Solid Waste Considerations

Many liquid and solid wastes generated in the pesticide industry have been classified as "hazardous" by regulations under the Resource Conservation and Recovery Act (RCRA) (U.S. EPA, 1980b). Specific waste streams within specific processes have been designated as hazardous, as well as specific products and raw materials. The economic impact of compliance with RCRA regulations has been initially reviewed in order to allow a separate economic contractor to assess the potential impact of

these regulations. RCRA management costs were estimated using procedures described in the Draft Final Guidance for RCRA Interim Status Standards (ISS) Costs, Office of Analysis and Evaluation, Revised April 1981. The costs include: (1) runoff collection and treatment system, (2) closure plan, (3) off-site management, (4) administration, (5) record-keeping, (6) monitoring and testing, (7) training, (8) contingency plan, and (9) closure and post closure financial responsibilities as applicable to each type of facility. The RCRA ISS management costs associated with these regulations are estimated to be $73,000 annually for the industry. Facilities which treat, store, dispose, or transport hazardous wastes were evaluated on a case-by-case basis. It is estimated that these costs will be $1.1 million annually with no additional capital expenditures.

Metal separation systems have been recommended for Subcategories 3, 5, and 7 of this document for the removal of copper and zinc. Adjustment of pH using sodium hydroxide in these systems will create zinc and copper hydroxide sludges. The quantities of sludge generated are estimated to be:

Cubic Yards of Sludge Generated Per Year Per MGD	
Copper	Zinc
102,000	5,540

Activated sludge systems have been recommended for Subcategory 10 pesticides that were excluded from the BPT regulation. Sludges generated in these systems are thickened, digested, and vacuum filtered to a solids content of 15 percent. The quantity of sludge generated by plants in this subcategory is estimated to be:

Cubic Yards of Sludge Generated Per Year Per MGD
7,720

Contract hauling of wastewaters generated in volumes less than 1,000 gallons per day has been recommended by this study. Under the RCRA regulations proposed by EPA, disposal of wastes off-site would require preparation of a manifest to track the movement of the waste from the generator's premises to a permanent off-site treatment, storage, or disposal facility.

Protection of Ground Water

Deep well injection is practiced at 17 plants in the pesticide industry. Since this method of disposal has not been recommended by this study, its potential impact on groundwater pollution will not be addressed.

Evaporation ponds are the only earthen basins recommended as a treatment technology in this study. Unless the natural soil is impervious, lining

of the basin will be required to ensure that ground water is protected. The basins designed and costed in this study have a liner included.

Spray irrigation of process wastewaters is practiced at three plants in the industry. Since this is not a technology recommended in this study, its potential for pollution of the ground water will not be addressed.

Table VIII-1. Basis for Capital Costs Computations
(September 1979 Dollars)

Item	Capital Cost
Land	$30,000 per acre
Excavation	$6.25 per cubic yard
Materials	
Reinforced Concrete	$260 per cubic yard
Machined Steel	$2.00 per pound
Epoxy Coating	$2.50 per square foot
Liner	$0.90 per square foot
Sitework, electrical, piping and instrumentation	48% of total equipment cost
Engineering	15% of construction cost
Contingency	15% of construction cost

Table VIII-2. Basis of Annual Cost Computations
(September 1979 Dollars)

Item	Capital Cost
Capital Recovery (0.163)	10 years at 10%
Taxes and Insurance	2% of capital cost
Manpower	
Labor	$15,000 per worker per year including fringe benefits
Supervision	$20,000 per worker per year including fringe benefits
Maintenance Materials	4% of capital cost
Sludge Disposal	$25 per cubic yard (non-hazardous) $60 per cubic yard (hazardous)
Water	$0.12 per thousand gallons
Activated Carbon	$0.60 per pound
Chemicals Consumed	
Caustic Soda (50%)	$0.10 per dry pound
Chlorine	$0.15 per pound
Ferric Chloride	$0.20 per pound
Lime	$50 per ton
Methanol	$0.70 per gallon
Chemicals Recovered	
Methylene Chloride	$0.10 per pound
Pesticides	$2.50 per pound
Energy Consumed	
Electricity	$0.05 per kilowatt-hour
Gas	$3.50 per million cubic feet
Steam	$7.50 per thousand pounds
Energy Recovered	
Thermal	$6.25 per million BTU

Table VIII-3. Capital Cost Summary by Subcategory

Subcategory	Cost ($1,000s)					
	Level 1		Level 2		Level 3	
	High	Low	High	Low	High	Low
1	2770	702	2930	862	3340	1270
2	2960	892	3120	1050	3530	1460
3	3350	942	3510	1100	3920	1510
4	3340	1270	3500	1430	3910	1840
5	3540	1130	3700	1290	4110	1700
6	160*	16.4*	--	--	--	--
7	1480†	797†	1580†	897†	1740†	1060†
8	630	290	790	450	1190	854
9	950	610	1110	770	1510	1170
10	4690	2620	4850	2780	5250	3180
11	160*	16.4*	--	--	--	--
12	160*	16.4*	--	--	--	--
13	160*	16.4*	--	--	--	--

Costs itemized at a design flow of 0.1 MGD unless otherwise specified.

* Flow = 500 GPD; however, costs for flows of 5,000 and 50 GPD are also available.

† Design flow = 0.01 MGD.

Table VIII-4. Annual Cost Summary by Subcategory

Subcategory	Cost ($1,000s)					
	Level 1		Level 2		Level 3	
	High	Low	High	Low	High	Low
1	1310	371	1340	406	1720	785
2	1420	481	1450	516	1830	895
3	2210	486	2240	521	2620	900
4	1940	1000	1970	1040	2350	1420
5	2320	596	2360	631	2730	1010
6	44.6*	10.5*	--	--	--	--
7	943†	462†	967†	486†	1080†	596†
8	190	190	225	225	604	604
9	332	332	367	367	746	746
10	2340	1380	2380	1420	2760	1800
11	44.6*	10.5*	--	--	--	--
12	44.6*	10.5*	--	--	--	--
13	44.6*	10.5*	--	--	--	--

Costs itemized at a design flow of 0.1 MGD unless otherwise specified.

* Flow = 500 GPD; however, costs for flows of 5,000 and 50 GPD are also available.
† Design flow = 0.01 MGD.

Table VIII-5. Energy Cost Summary by Subcategory

Subcategory	Cost ($1,000s)					
	Level 1		Level 2		Level 3	
	High	Low	High	Low	High	Low
1	133	122	134	122	163	151
2	180	168	181	170	210	198
3	142	129	143	130	172	158
4	187	176	188	177	217	205
5	189	176	190	176	219	205
6	0.40*	0.24*	--	--	--	--
7	39†	34†	40†	34†	43†	37†
8	36	42	37	43	66	72
9	84	90	85	91	114	120
10	216	204	217	205	225	233
11	0.40*	0.24*	--	--	--	--
12	0.40*	0.24*	--	--	--	--
13	0.40*	0.24*	--	--	--	--

Costs itemized at a design flow of 0.1 MGD unless otherwise specified.

* Flow = 500 GPD; however, costs for flows of 5,000 and 50 GPD are also available.
† Design flow = 0.01 MGD.

Table VIII-6. Unit Treatment Cost Itemization for Subcategory 1
(Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	36	36	8	8	0.3	0.3
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	---	---	---	---	---	---
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	140	---	37	---	8
Neutralization	48	---	20	---	1	---
Dual Media Filter	100	---	24	---	0.3	---
Pumping Station	31	---	7	---	0.2	---
Pumping Station	36	---	8	---	0.3	---
Activated Carbon	240	---	65	---	1	---
Carbon Regeneration	160	---	130	---	8	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	865	307	409	148	15.4	12.6
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	965	407	433	172	15.7	12.9

Table VIII-6. Unit Treatment Cost Itemization for Subcategory 1 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	1130	568	542	281	19	16.2
Alternatives for low-flow wastewater disposal						
Evaporation Pond (500 gpd)	160	16.4	28	10.5	0.40	0.24
Contract Hauling (500 gpd)	--	--	44.6	18.6	--	--

* Correspond to capital high/low system specified.

Table VIII-7. Unit Treatment Cost Itemization for Subcategory 1 (Design flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	42	42	9	9	0.5	0.5
Equalization (12-hr)	130	130	32	32	1	1
Steam Stripper	---	---	---	---	---	---
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	240	---	140	---	78
Neutralization	53	---	23	---	1	---
Dual Media Filter	160	---	35	---	1	---
Pumping Station	36	---	8	---	0.3	---
Pumping Station	42	---	9	---	0.5	---
Activated Carbon	1100	---	470	---	4	---
Carbon Regeneration	580	---	530	---	89	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	2770	702	1310	371	133	122
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	2930	862	1340	406	134	122

Table VIII-7. Unit Treatment Cost Itemization for Subcategory 1 (Design flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	26	26
SUBTOTAL	3340	1270	1720	785	163	151

* Correspond to capital high/low system specified.

Table VIII-8. Unit Treatment Cost Itemization for Subcategory 2 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	36	36	8	8	0.3	0.3
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	120	120	44	44	14	14
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	140	---	37	---	8
Neutralization	48	---	20	---	1	---
Dual Media Filter	100	---	24	---	0.3	---
Pumping Station	31	---	7	---	0.2	---
Pumping Station	36	---	8	---	0.3	---
Activated Carbon	240	---	65	---	1	---
Carbon Regeneration	160	---	130	---	8	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	985	427	453	192	29.4	26.6
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	1080	527	477	216	29.7	26.9

Table VIII-8. Unit Treatment Cost Itemization for Subcategory 2 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	1250	688	586	325	33	30.2
Alternatives for low-flow wastewater disposal						
Evaporation Pond (500 gpd)	160	16.4	28	10.5	0.40	0.24
Contract Hauling (500 gpd)	--	--	44.6	18.6	--	--

* Correspond to capital high/low system specified.

Table VIII-9. Unit Treatment Cost Itemization for Subcategory 2 (Design Flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	42	42	9	9	0.5	0.5
Equalization (12-hr)	130	130	32	32	1	1
Steam Stripper	190	190	110	110	47	47
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	240	---	140	---	78
Neutralization	53	---	23	---	1	---
Dual Media Filter	160	---	35	---	1	---
Pumping Station	36	---	8	---	0.3	---
Pumping Station	42	---	9	---	0.5	---
Activated Carbon	1100	---	470	---	4	---
Carbon Regeneration	580	---	530	---	89	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	2960	892	1420	481	180	168
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	3120	1050	1450	516	181	170

Table VIII-9. Unit Treatment Cost Itemization for Subcategory 2 (Design Flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	26	26
SUBTOTAL	3530	1460	1830	895	210	198

* Correspond to capital high/low system specified.

Table VIII-10. Unit Treatment Cost Itemization for Subcategory 3 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	36	36	8	8	0.3	0.3
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	---	---	---	---	---	---
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	260	140	260	60	5	4
Hydrolysis	---	140	---	37	---	8
Neutralization	48	---	20	---	1	---
Dual Media Filter	100	---	24	---	0.3	---
Pumping Station	31	---	7	---	0.2	---
Pumping Station	36	---	8	---	0.3	---
Activated Carbon	240	---	65	---	1	---
Carbon Regeneration	160	---	130	---	8	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	20	0.5	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	1120	447	689	208	20.4	16.6
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	1220	547	713	232	20.7	16.9

Table VIII-10. Unit Treatment Cost Itemization for Subcategory 3 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	1390	708	822	342	24	20.2
Alternatives for low-flow wastewater disposal						
Evaporation Pond (500 gpd)	160	16.4	28	10.5	0.40	0.24
Contract Hauling (500 gpd)	--	--	44.6	18.6	--	--

* Correspond to capital high/low system specified.

Table VIII-11. Unit Treatment Cost Itemization for Subcategory 3 (Design Flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	42	42	9	9	0.5	0.5
Equalization (12-hr)	130	130	32	32	1	1
Steam Stripper	---	---	---	---	---	---
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	580	240	700	110	9	7
Hydrolysis	---	240	---	140	---	78
Neutralization	53	---	23	---	1	---
Dual Media Filter	160	---	35	---	1	---
Pumping Station	36	---	8	---	0.3	---
Pumping Station	42	---	9	---	0.5	---
Activated Carbon	1100	---	470	---	4	---
Carbon Regeneration	580	---	530	---	89	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	204	5	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	3350	942	2210	486	142	129
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	3510	1100	2240	521	143	130

Table VIII-11. Unit Treatment Cost Itemization for Subcategory 3 (Design Flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	26	26
SUBTOTAL	3920	1510	2620	900	172	158

* Correspond to capital high/low system specified.

Table VIII-12. Unit Treatment Cost Itemization for Subcategory 4 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	36	36	8	8	0.3	0.3
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	120	120	44	44	14	14
Chemical Oxidation	230	230	210	210	3	3
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	140	---	37	---	8
Neutralization	48	---	20	---	1	---
Dual Media Filter	100	---	24	---	0.3	---
Pumping Station	31	---	7	---	0.2	---
Pumping Station	36	---	8	---	0.3	---
Activated Carbon	240	---	65	---	1	---
Carbon Regeneration	160	---	130	---	8	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	1220	657	663	402	32.4	29.6
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	1320	757	687	426	32.7	29.9

Table VIII-12. Unit Treatment Cost Itemization for Subcategory 4 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	1480	918	796	535	3.6	33.2
Alternatives for low-flow wastewater disposal						
Evaporation Pond (500 gpd)	160	16.4	28	10.5	0.40	0.24
Contract Hauling (500 gpd)	--	--	44.6	18.6	--	--

* Correspond to capital high/low system specified.

Table VIII-13. Unit Treatment Cost Itemization for Subcategory 4 (Design Flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	42	42	9	9	0.5	0.5
Equalization (12-hr)	130	130	32	32	1	1
Steam Stripper	190	190	110	110	47	47
Chemical Oxidation	380	380	520	520	7	7
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	240	---	140	---	78
Neutralization	53	---	23	---	1	---
Dual Media Filter	160	---	35	---	1	---
Pumping Station	36	---	8	---	0.3	---
Pumping Station	42	---	9	---	0.5	---
Activated Carbon	1100	---	470	---	4	---
Carbon Regeneration	580	---	530	---	89	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	--
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	3340	1270	1940	1000	187	176
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	3500	1430	1970	1040	188	177

Table VIII-13. Unit Treatment Cost Itemization for Subcategory 4 (Design Flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	26	26
SUBTOTAL	3910	1840	2350	1420	217	205

* Correspond to capital high/low system specified.

Table VIII-14. Unit Treatment Cost Itemization for Subcategory 5 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	36	36	8	8	0.3	0.3
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	120	120	44	44	14	14
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	260	140	260	60	5	4
Hydrolysis	---	140	---	37	---	8
Neutralization	48	---	20	---	1	---
Dual Media Filter	100	---	24	---	0.3	---
Pumping Station	31	---	7	---	0.2	---
Pumping Station	36	---	8	---	0.3	---
Activated Carbon	240	---	65	---	1	---
Carbon Regeneration	160	---	130	---	8	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	20	0.5	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	1240	567	733	252	34.4	30.6
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	1340	667	757	276	34.7	30.9

Table VIII-14. Unit Treatment Cost Itemization for Subcategory 5 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	1510	828	866	386	38	34.2
Alternatives for low-flow wastewater disposal						
Evaporation Pond (500 gpd)	160	16.4	28	10.5	0.40	0.24
Contract Hauling (500 gpd)	--	--	44.6	18.6	--	--

* Correspond to capital high/low system specified.

Table VIII-15. Unit Treatment Cost Itemization for Subcategory 5 (Design Flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	42	42	9	9	0.5	0.5
Equalization (12-hr)	130	130	32	32	1	1
Steam Stripper	190	190	110	110	47	47
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	580	240	700	110	9	7
Hydrolysis	---	240	---	140	---	78
Neutralization	53	---	23	---	1	---
Dual Media Filter	160	---	35	---	1	---
Pumping Station	36	---	8	---	0.3	---
Pumping Station	42	---	9	---	0.5	---
Activated Carbon	1100	---	470	---	4	---
Carbon Regeneration	580	---	530	---	89	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	204	5	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	3540	1130	2320	596	189	176
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	3700	1290	2360	631	190	176

Table VIII-15. Unit Treatment Cost Itemization for Subcategory 5 (Design Flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	26	26
SUBTOTAL	4110	1700	2730	1010	219	205

* Correspond to capital high/low system specified.

Table VIII-16. Unit Treatment Cost Itemization for Subcategory 6

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE = Net Evaporation.
psi = pounds per square inch.

Table VIII-17. Unit Treatment Cost Itemization for Subcategory 7 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	36	36	8	8	0.3	0.3
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	120	120	44	44	14	14
Chemical Oxidation	230	230	210	210	3	3
Metals Separation	260	140	260	60	5	4
Hydrolysis	---	140	---	37	---	8
Neutralization	48	---	20	---	1	---
Dual Media Filter	100	---	24	---	0.3	---
Pumping Station	31	---	7	---	0.2	---
Pumping Station	36	---	8	---	0.3	---
Activated Carbon	240	---	65	---	1	---
Carbon Regeneration	160	---	130	---	8	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	20	0.5	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	1480	797	943	462	39.2	33.6
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	1580	897	967	486	39.5	33.9

Table VIII-17. Unit Treatment Cost Itemization for Subcategory 7 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	1740	1060	1080	596	42.8	37.2

* Correspond to capital high/low system specified.

Table VIII-18. Unit Treatment Cost Itemization for Subcategory 8 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	---	---	---	---	---	---
Equalization (12-hr)	---	---	---	---	---	---
Steam Stripper	---	---	---	---	---	---
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Dual Media Filter	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Activated Carbon	---	---	---	---	---	---
Carbon Regeneration	---	---	---	---	---	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	150	67	130	86	4	4
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	250	167	154	110	4.3	4.3

Table VIII-18. Unit Treatment Cost Itemization for Subcategory 8 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	411	328	263	219	7.6	7.6

* Correspond to capital high/low system specified.

Table VIII-19. Unit Treatment Cost Itemization for Subcategory 8 (Design Flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	---	---	---	---	---	---
Equalization (12-hr)	---	---	---	---	---	---
Steam Stripper	---	---	---	---	---	---
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Dual Media Filter	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Activated Carbon	---	---	---	---	---	---
Carbon Regeneration	---	---	---	---	---	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	630	290	190	190	36	42
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	790	450	225	225	37	43

Table VIII-19. Unit Treatment Cost Itemization for Subcategory 8 (Design Flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	26	26
SUBTOTAL	1190	854	604	604	65.5	71.5

* Correspond to capital high/low system specified.

Table VIII-20. Unit Treatment Cost Itemization for Subcategory 9 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	---	---	---	---	---	---
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	120	120	44	44	14	14
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Dual Media Filter	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Activated Carbon	---	---	---	---	---	---
Carbon Regeneration	---	---	---	---	---	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	334	251	191	147	18.3	18.3
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	434	351	215	171	18.6	18.6

Table VIII-20. Unit Treatment Cost Itemization for Subcategory 9 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	595	512	324	280	21.9	21.9
Alternatives for low-flow wastewater disposal						
Evaporation Pond (500 gpd)	160	16.4	28	10.5	0.40	0.24
Contract Hauling (500 gpd)	--	--	44.6	18.6	--	--

* Correspond to capital high/low system specified.

Table VIII-21. Unit Treatment Cost Itemization for Subcategory 9 (Design Flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	---	---	---	---	---	---
Equalization (12-hr)	130	130	32	32	1	1
Steam Stripper	190	190	110	110	47	47
Chemical Oxidation	---	---	---	---	---	---
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Dual Media Filter	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Activated Carbon	---	---	---	---	---	---
Carbon Regeneration	---	---	---	---	---	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Equalization (24-hr)	---	---	---	---	---	---
Neutralization	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Nutrient Addition	---	---	---	---	---	---
Aeration Basin	---	---	---	---	---	---
Clarification	---	---	---	---	---	---
Sludge Thickening	---	---	---	---	---	---
Aerobic Digestion	---	---	---	---	---	---
Vacuum Filtration	---	---	---	---	---	---
Pumping Station	---	---	---	---	---	---
Contract Hauling						
Activated Sludge	---	---	---	---	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	950	610	332	332	84	90
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	1110	770	367	367	85	91

Table VIII-21. Unit Treatment Cost Itemization for Subcategory 9 (Design Flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	26	26
SUBTOTAL	1510	1170	746	746	114	120

* Correspond to capital high/low system specified.

Table VIII-22. Unit Treatment Cost Itemization for Subcategory 10 (Design Flow = 0.01 MGD)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	36	36	8	8	0.3	0.3
Equalization (12-hr)	64	64	17	17	0.3	0.3
Steam Stripper	120	120	44	44	14	14
Chemical Oxidation	230	230	210	210	3	3
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	140	---	37	---	8
Neutralization	48	---	20	---	1	---
Dual Media Filter	100	---	24	---	0.3	---
Pumping Station	31	---	7	---	0.2	---
Pumping Station	36	---	8	---	0.3	---
Activated Carbon	240	---	65	---	1	---
Carbon Regeneration	160	---	130	---	8	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	36	36	8	8	0.3	0.3
Equalization (24-hr)	76	76	20	20	0.4	0.4
Neutralization	48	48	20	20	1	1
Pumping Station	36	36	8	8	0.3	0.3
Nutrient Addition	29	29	11	11	1	1
Aeration Basin	33	33	12	12	0.3	0.3
Clarification	260	260	55	55	3	3
Sludge Thickening	72	72	11	11	1	1
Aerobic Digestion	31	31	12	12	1	1
Vacuum Filtration	130	130	38	38	1	1
Pumping Station	29	29	7	7	0.2	0.2
Contract Hauling						
Activated Sludge	---	---	4	2	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	150	67	130	86	4	4
SUBTOTAL	2000	1440	869	606	41.9	40.8
Level 2						
Dual Media Filters	100	100	24	24	0.3	0.3
SUBTOTAL	2100	1540	893	630	42.2	41.1

Table VIII-22. Unit Treatment Cost Itemization for Subcategory 10 (Design Flow = 0.01 MGD) (Continued, Page 2 of 2)

Design Flow = 0.01 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	36	36	8	8	0.3	0.3
Activated Carbon	15	15	14	14	1	1
Carbon Regeneration	110	110	87	87	2	2
SUBTOTAL	2260	1700	1000	739	45.5	44.4
Alternatives for low-flow wastewater disposal						
Evaporation Pond (500 gpd)	160	16.4	28	10.5	0.40	0.24
Contract Hauling (500 gpd)	--	--	44.6	18.6	--	--

* Correspond to capital high/low system specified.

Table VIII-23. Unit Treatment Cost Itemization for Subcategory 10 (Design Flow = 0.1 MGD)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	42	42	9	9	0.5	0.5
Equalization (12-hr)	130	130	32	32	1	1
Steam Stripper	190	190	110	110	47	47
Chemical Oxidation	380	380	520	520	7	7
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	240	---	140	---	78
Neutralization	53	---	23	---	1	---
Dual Media Filter	160	---	35	---	1	---
Pumping Station	36	---	8	---	0.3	---
Pumping Station	42	---	9	---	0.5	---
Activated Carbon	1100	---	470	---	4	---
Carbon Regeneration	580	---	530	---	89	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	42	42	9	9	0.5	0.5
Equalization (24-hr)	170	170	42	42	3	3
Neutralization	53	53	23	23	1	1
Pumping Station	42	42	9	9	0.5	0.5
Nutrient Addition	32	32	24	24	1	1
Aeration Basin	200	200	57	57	3	3
Clarification	320	320	72	72	3	3
Sludge Thickening	150	150	36	36	1	1
Aerobic Digestion	120	120	36	36	4	4
Vacuum Filtration	180	180	47	47	11	11
Pumping Station	34	34	7	7	0.3	0.3
Contract Hauling						
Activated Sludge	---	---	44	18	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	630	290	190	190	36	42
SUBTOTAL	4690	2620	2340	1380	216	204
Level 2						
Dual Media Filters	160	160	35	35	1	1
SUBTOTAL	4850	2780	2380	1420	217	205

Table VIII-23. Unit Treatment Cost Itemization for Subcategory 10 (Design Flow = 0.1 MGD) (Continued, Page 2 of 2)

Design Flow = 0.1 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	42	42	9	9	0.5	0.5
Activated Carbon	72	72	130	130	2	2
Carbon Regeneration	290	290	240	240	6	26
SUBTOTAL	5250	3180	2760	1800	225	233

* Correspond to capital high/low system specified.

Table VIII-24. Unit Treatment Cost Itemization for Subcategory 10 (Design Flow = 1.0 MGD)

Design Flow = 1.0 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 1						
Pumping Station	130	130	24	24	2	2
Equalization (12-hr)	340	340	95	95	13	13
Steam Stripper	500	500	620	620	470	470
Chemical Oxidation	1100	1100	4300	4300	35	35
Metals Separation	---	---	---	---	---	---
Hydrolysis	---	1100	---	1300	---	740
Neutralization	70	---	51	---	1	---
Dual Media Filter	420	---	100	---	2	---
Pumping Station	42	---	9	---	0.5	---
Pumping Station	130	---	24	---	2	---
Activated Carbon	14000	---	3900	---	25	---
Carbon Regeneration	3000	---	3600	---	660	---
Resin Adsorption	---	---	---	---	---	---
Resin Regeneration	---	---	---	---	---	---
Pumping Station	130	130	24	24	2	2
Equalization (24-hr)	510	510	150	150	26	26
Neutralization	70	70	51	51	1	1
Pumping Station	130	130	24	24	2	2
Nutrient Addition	48	48	130	130	1	1
Aeration Basin	1100	1100	290	290	35	35
Clarification	550	550	170	170	9	9
Sludge Thickening	330	330	72	72	5	5
Aerobic Digestion	520	520	140	140	30	30
Vacuum Filtration	320	320	110	110	4	4
Pumping Station	40	40	8	8	0.4	0.4
Contract Hauling						
Activated Sludge	---	---	442	184	---	---
Metals Sludge	---	---	---	---	---	---
Incineration	3200	1300	290	400	360	420
SUBTOTAL	26700	8220	14600	8090	1680	1800
Level 2						
Dual Media Filters	420	420	100	100	2	2
SUBTOTAL	27100	8640	14700	8190	1690	1800

Table VIII-24. Unit Treatment Cost Itemization for Subcategory 10 (Design Flow = 1.0 MGD) (Continued, Page 2 of 2)

Design Flow = 1.0 MGD	Cost ($1000s)					
	Capital		Annual*		Energy*	
	High	Low	High	Low	High	Low
Level 3						
Pump Station	130	130	24	24	2	2
Activated Carbon	470	470	1200	1200	4	4
Carbon Regeneration	1200	1200	1200	1200	250	250
SUBTOTAL	28900	10400	17100	10600	1940	2050

* Correspond to capital high/low system specified.

Table VIII-25. Unit Treatment Cost Itemization for Subcategory 11

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE = Net Evaporation.
psi = pounds per square inch.

Table VIII-26. Unit Treatment Cost Itemization for Subcategory 12

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE = Net Evaporation.
psi = pounds per square inch.

Table VIII-27. Unit Treatment Cost Itemization for Subcategory 13

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE = Net Evaporation.
psi = pounds per square inch.

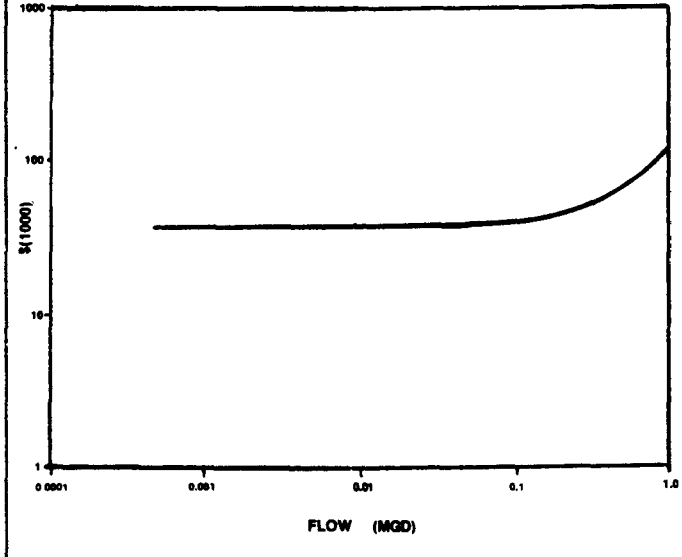
COMPONENTS INCLUDED

WET WELL

PUMPS

50 FT. OF PIPING

CAPITAL COST



ANNUAL COST

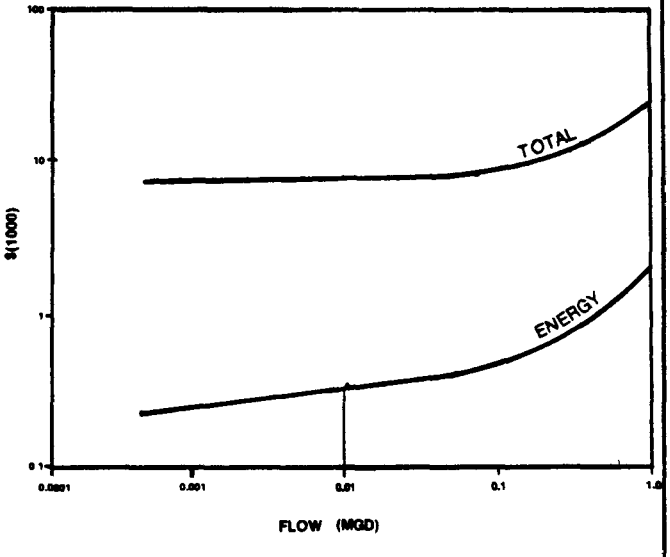


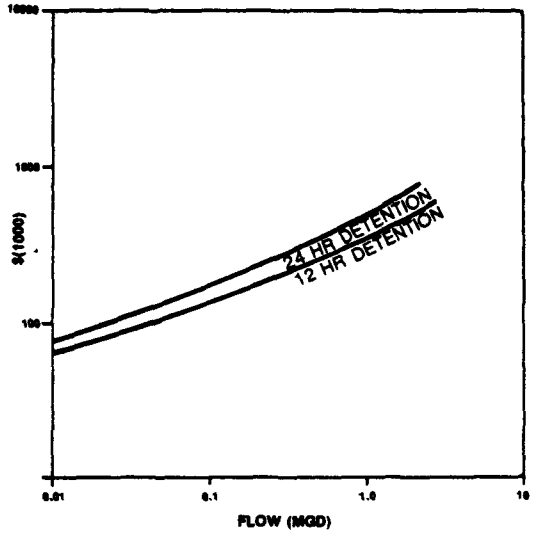
Figure VIII-1 TREATMENT COST CURVES
PUMP STATION

COMPONENTS INCLUDED

EQUALIZATION BASINS

AERATORS/MIXERS

CAPITAL COST



ANNUAL COST

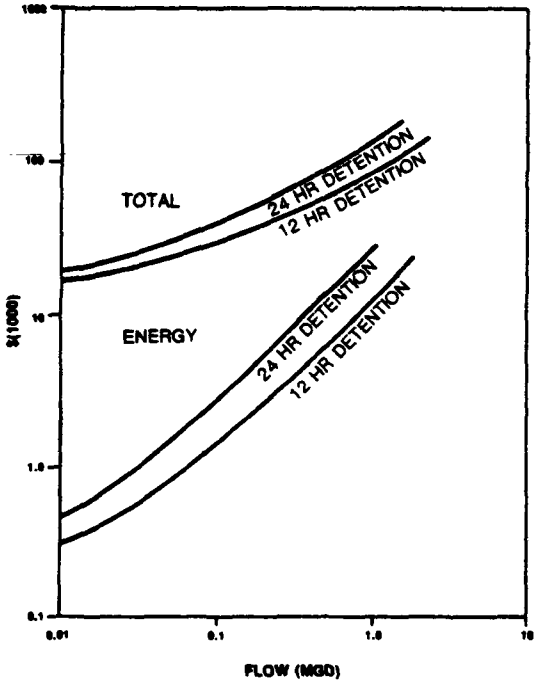
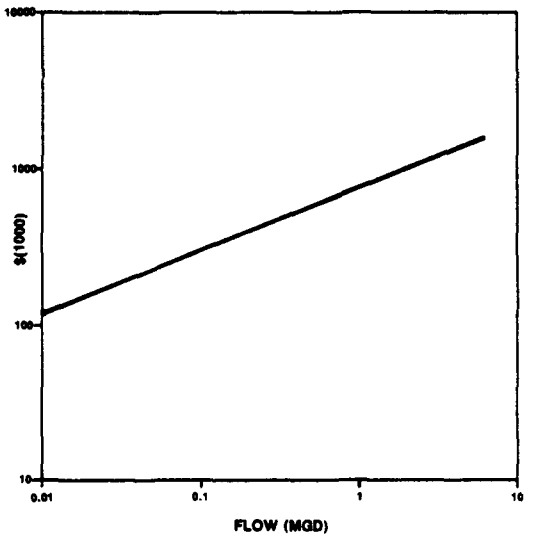


Figure VIII-2 TREATMENT COST CURVES
EQUALIZATION

COMPONENTS INCLUDED

FEED STORAGE DRUM
FEED PREHEATER
FEED PUMPS
STRIPPING COLUMN
OVERHEAD CONDENSER
SEPARATOR DRUM
HEAT EXCHANGER
EFFLUENT STORAGE DRUM

CAPITAL COST



ANNUAL COST

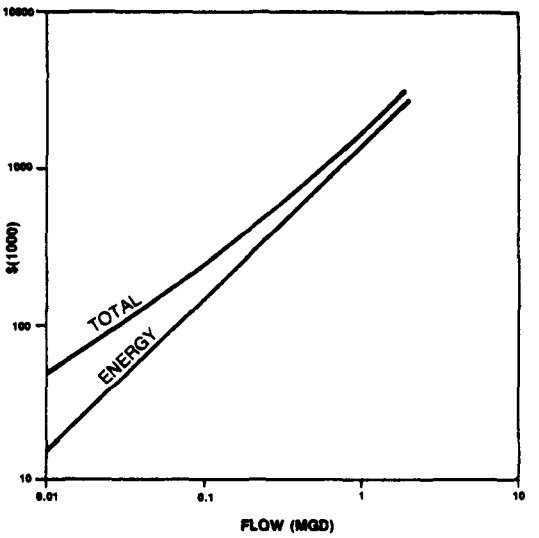
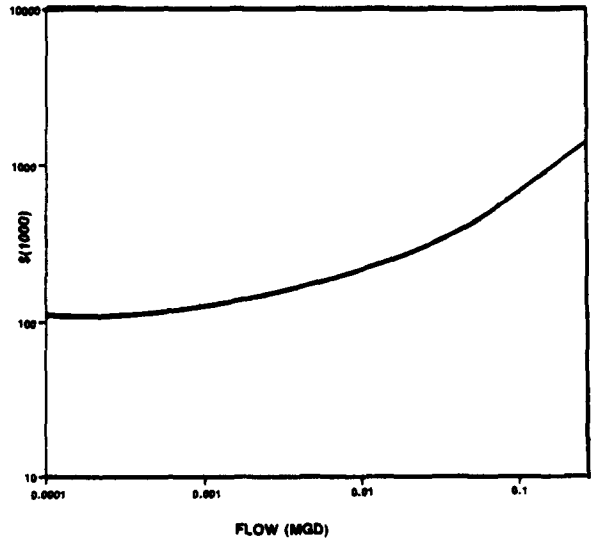


Figure VIII-3 TREATMENT COST CURVES
STEAM STRIPPING

COMPONENTS INCLUDED

FEED PUMPS
REACTOR VESSELS
RECIRCULATION PUMPS
CAUSTIC STORAGE
CHEMICAL FEEDERS
CHLORINE STORAGE
CHLORINATORS

CAPITAL COST



ANNUAL COST

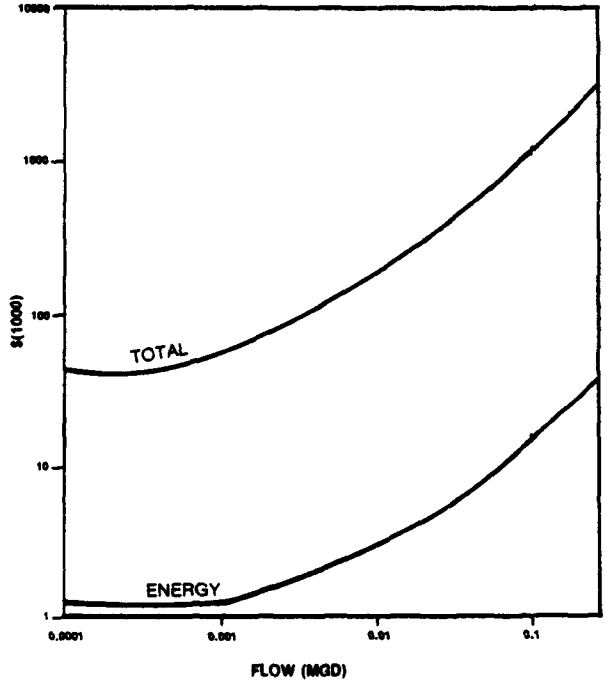
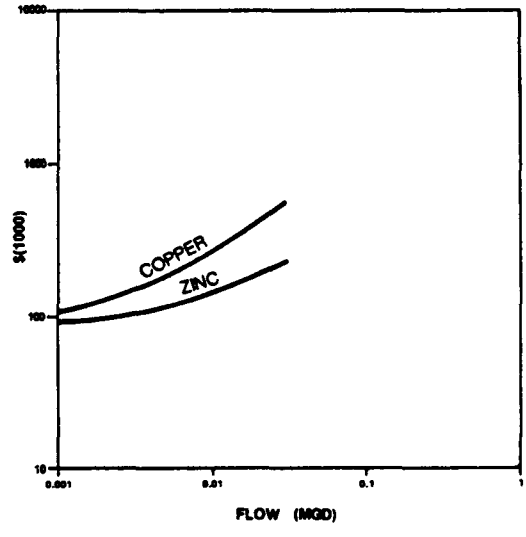


Figure VIII-4 TREATMENT COST CURVES
ALKALINE CHLORINATION

COMPONENTS INCLUDED

FEED PUMPS
MIXING TANK
FILTER PRESS
HOLDING TANK
CAUSTIC STORAGE
CHEMICAL FEEDERS
POLYMER STORAGE
POLYMER FEEDERS

CAPITAL COST



ANNUAL COST

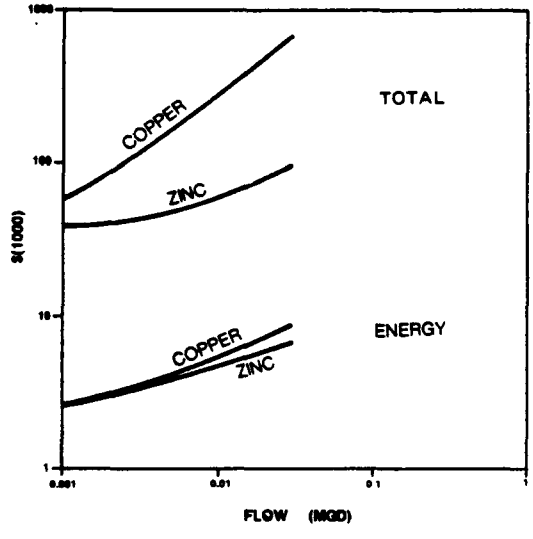
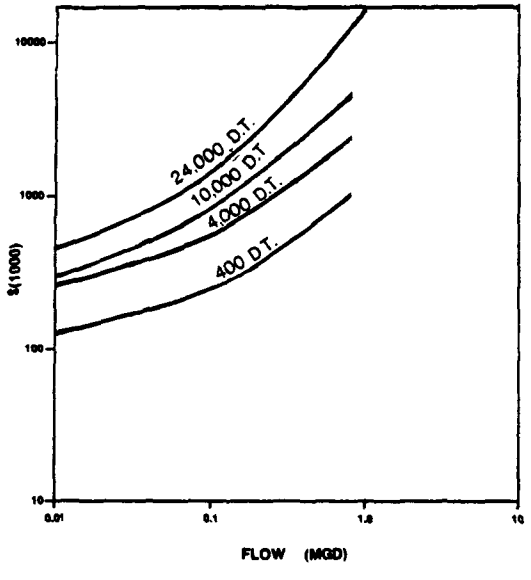


Figure VIII-5 TREATMENT COST CURVES
METALS SEPARATION

COMPONENTS INCLUDED

CAUSTIC STORAGE TANK
CHEMICAL FEEDER
MIXING TANK
HYDROLYSIS BASINS WITH COVERS
TEMPERATURE CONTROL
STEAM DELIVERY AND CONTROL

CAPITAL COST



ANNUAL COST

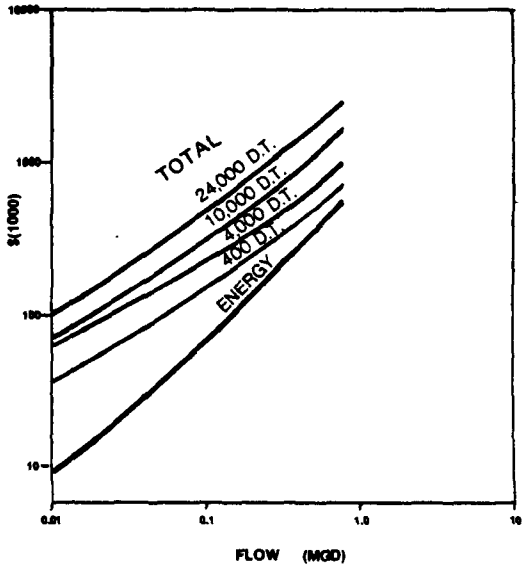
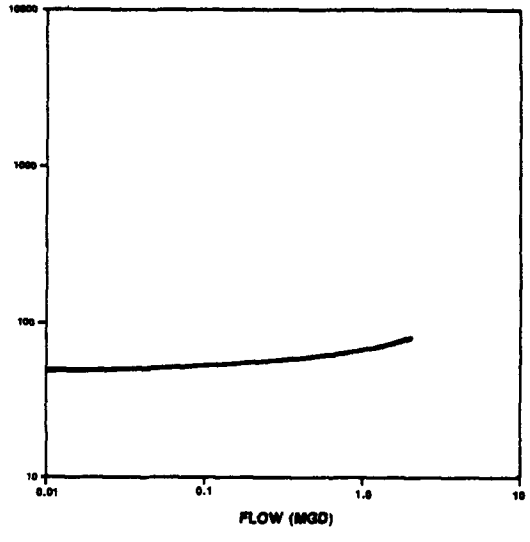


Figure VIII-6 TREATMENT COST CURVES
PESTICIDE HYDROLYSIS

COMPONENTS INCLUDED

CAUSTIC STORAGE TANK
CHEMICAL FEEDER
MIXING TANK

CAPITAL COST



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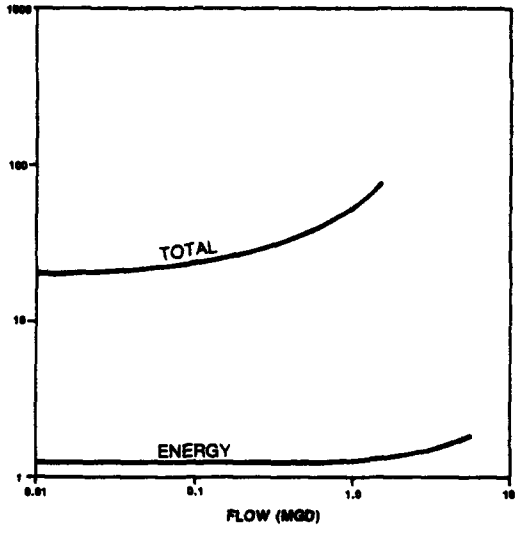


Figure VIII-7 TREATMENT COST CURVES
NEUTRALIZATION

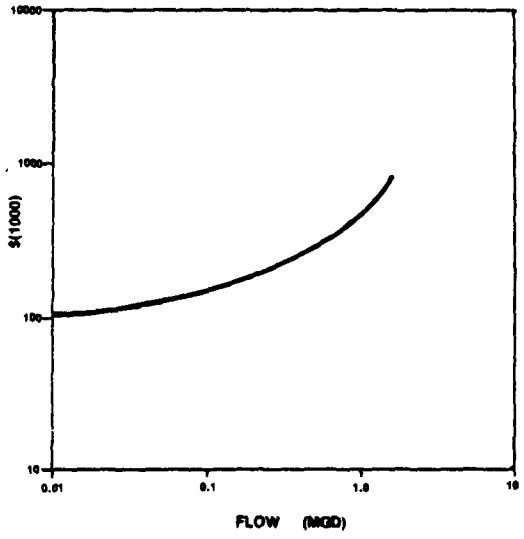
COMPONENTS INCLUDED

FEED PUMPS

FILTERS

BACKWASH PUMPS

CAPITAL COST



ANNUAL COST

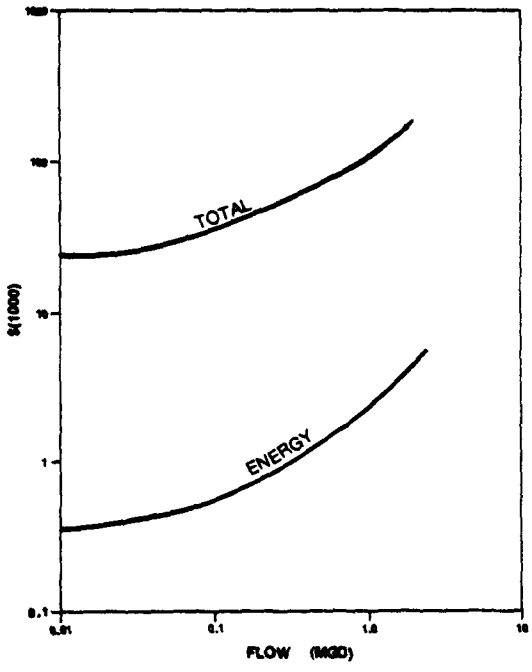
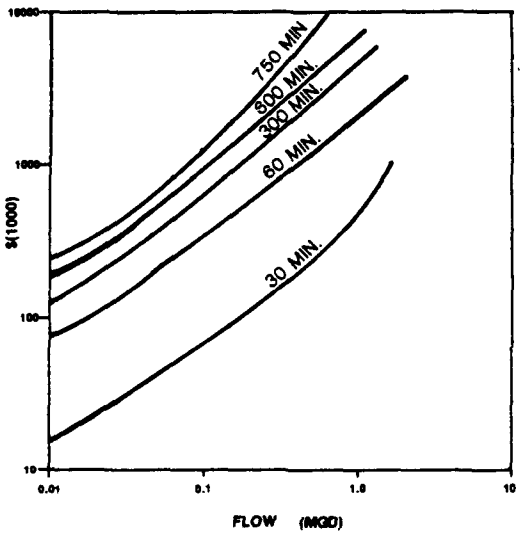


Figure VIII-8 TREATMENT COST CURVES
DUAL MEDIA PRESSURE FILTRATION

COMPONENTS INCLUDED

CARBON COLUMNS
BACKWASH PUMPS

CAPITAL COST



ANNUAL COST

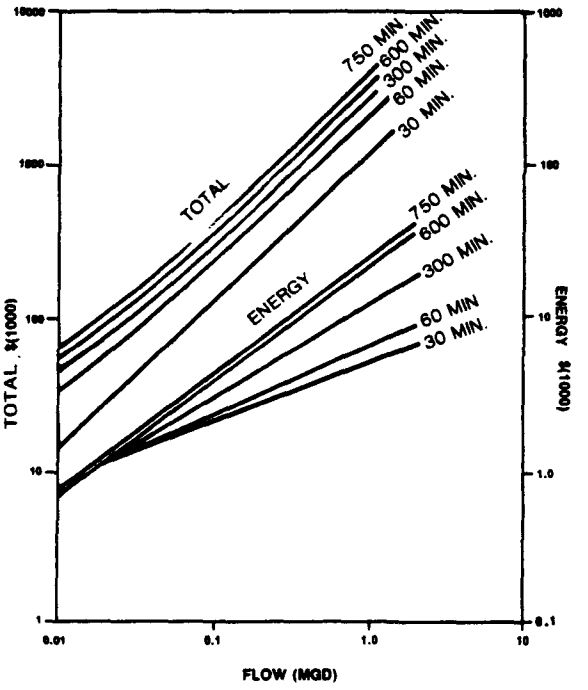
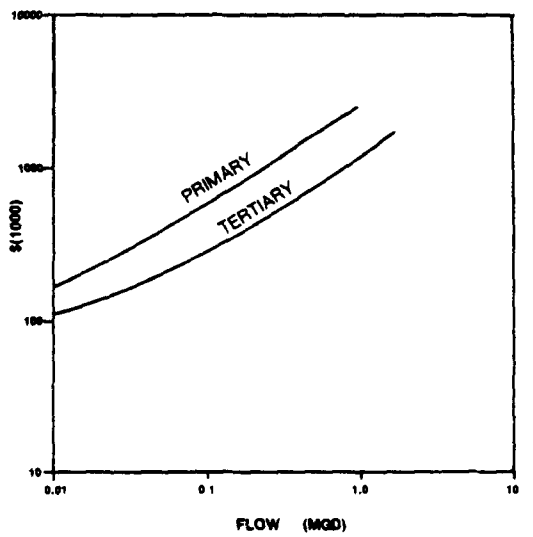


Figure VIII-9 TREATMENT COST CURVES
CARBON ADSORPTION

COMPONENTS INCLUDED

CARBON MAKE-UP TANK
MAKE-UP CARBON WASH TANK
SLURRY PUMPS
SPENT CARBON DEWATERING TANK
FURNACE
QUENCH TANK
REGENERATED CARBON WASH TANK
WASH WATER PUMPS
AFTER BURNER
SCRUBBER

CAPITAL COST



ANNUAL COST

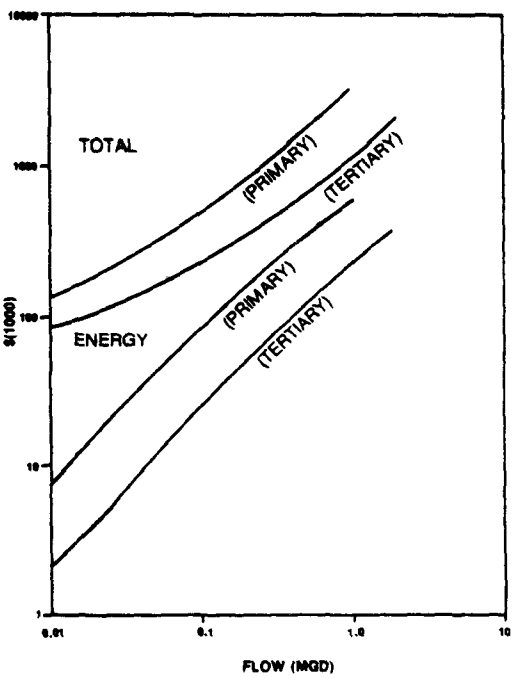
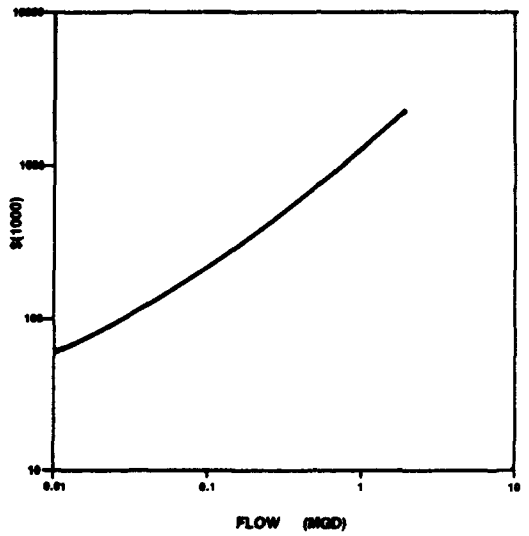


Figure VIII-10 TREATMENT COST CURVES
CARBON REGENERATION

COMPONENTS INCLUDED

RESIN COLUMNS
BACKWASH PUMPS

CAPITAL COST



ANNUAL COST

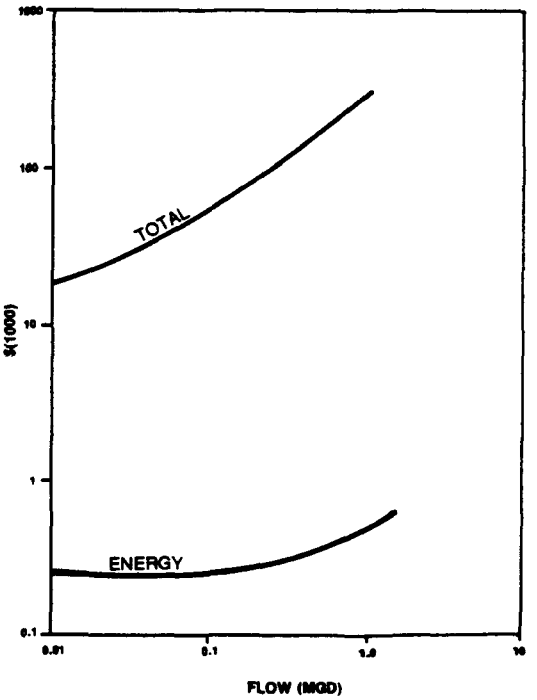
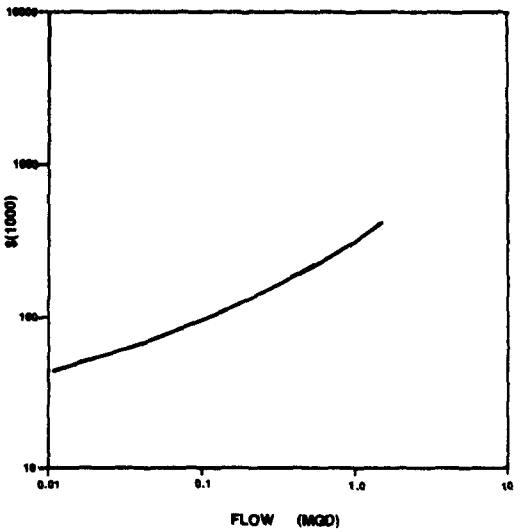


Figure VIII-11 TREATMENT COST CURVES
RESIN ADSORPTION

COMPONENTS INCLUDED

METHANOL STORAGE
PUMP
BATCH DISTILLATION COLUMN
OVERHEAD CONDENSER
REFLUX DRUM

CAPITAL COST



ANNUAL COST

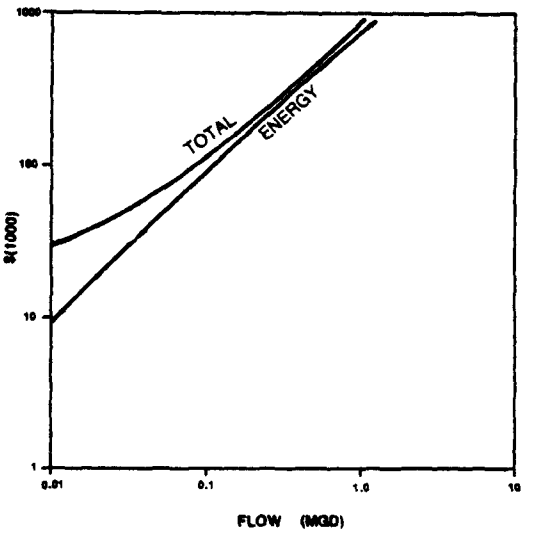
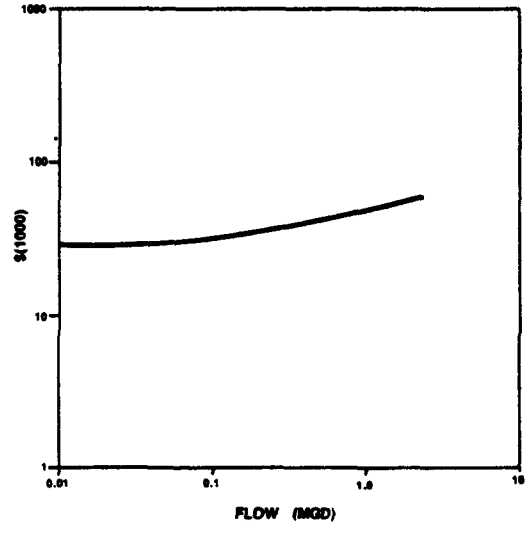


Figure VIII-12 TREATMENT COST CURVES
RESIN REGENERATION

COMPONENTS INCLUDED

PHOSPHORIC ACID STORAGE
ANHYDROUS AMMONIA STORAGE
CHEMICAL FEED PUMPS

CAPITAL COST



ANNUAL COST

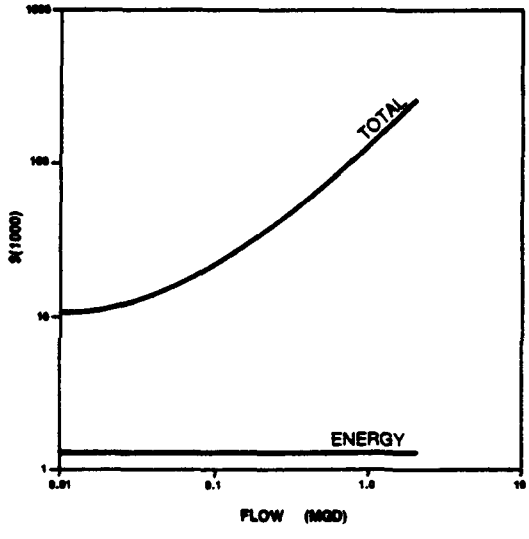


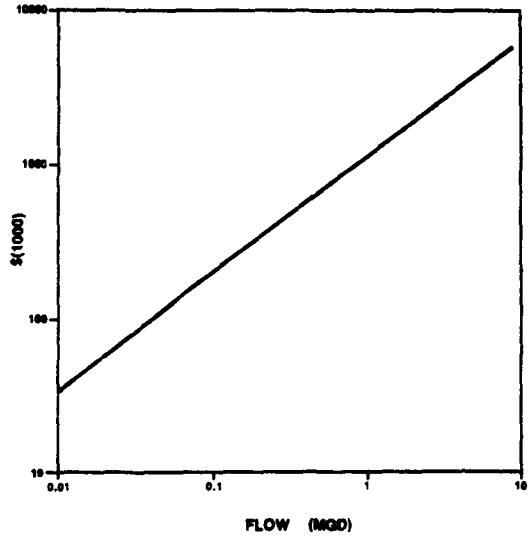
Figure VIII-13 TREATMENT COST CURVES
NUTRIENT ADDITION

COMPONENTS INCLUDED

AERATION BASINS

AERATORS

CAPITAL COST



ANNUAL COST

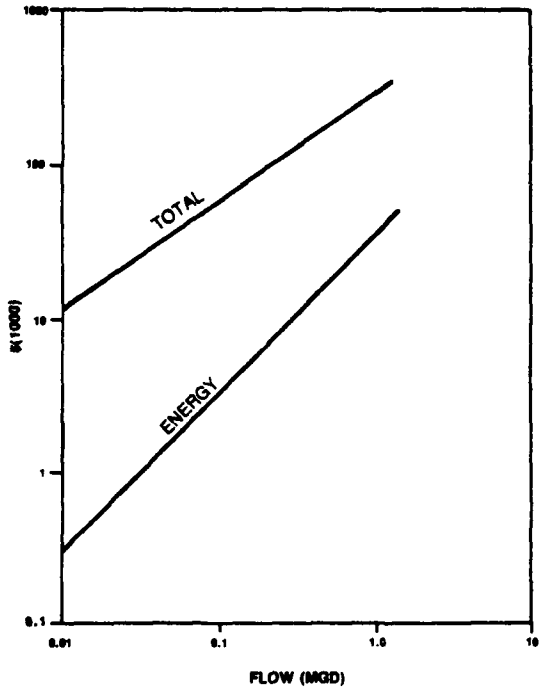


Figure VIII-14 TREATMENT COST CURVES
AERATION BASIN

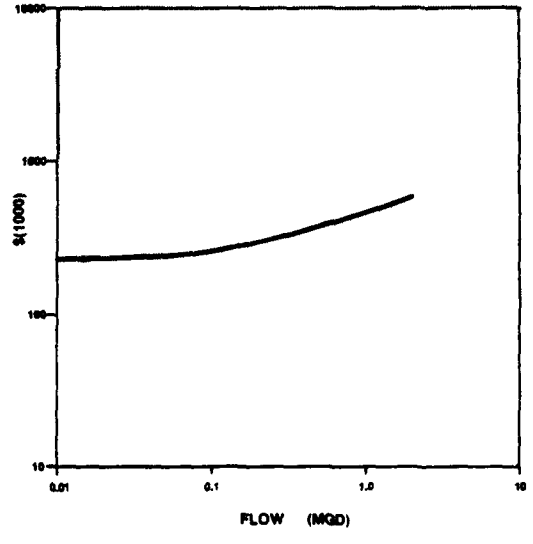
COMPONENTS INCLUDED

CLARIFIER

SLUDGE RECYCLE PUMPS

POLYMER STORAGE AND FEEDER

CAPITAL COST



ANNUAL COST

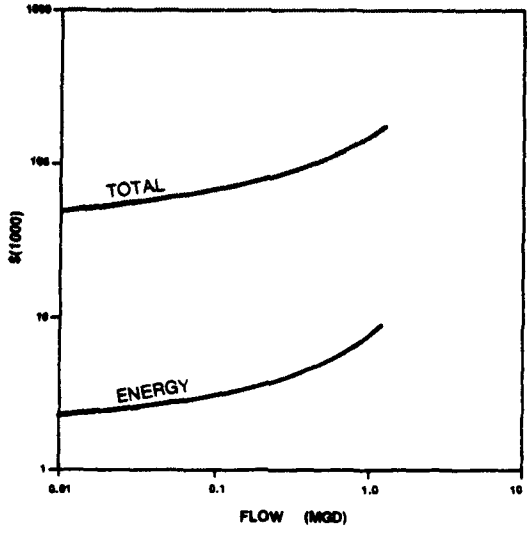
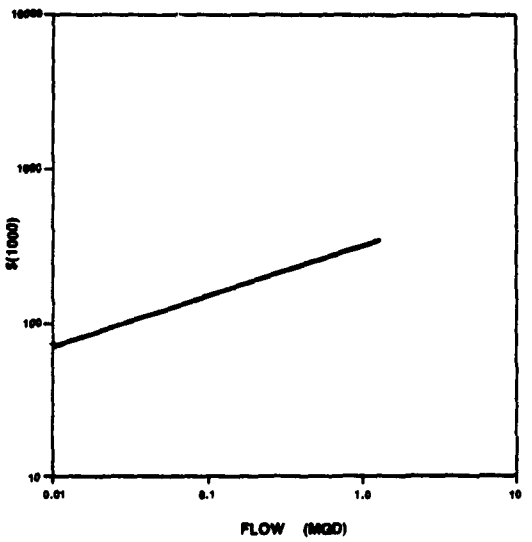


Figure VIII-15 TREATMENT COST CURVES
CLARIFICATION

COMPONENTS INCLUDED

AIR FLOTATION TANK AND MECHANISM
SLUDGE RECYCLE PUMPS

CAPITAL COST



ANNUAL COST

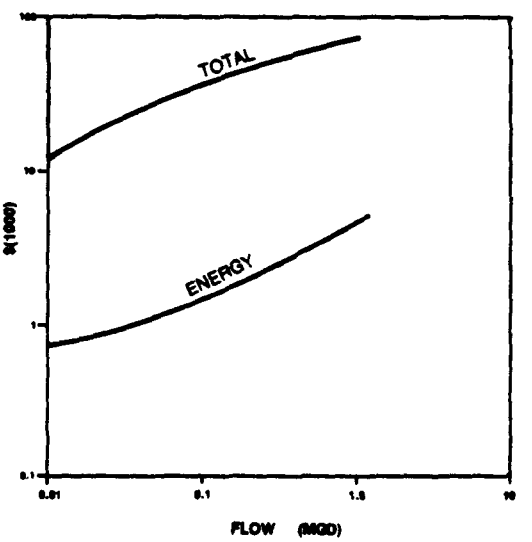
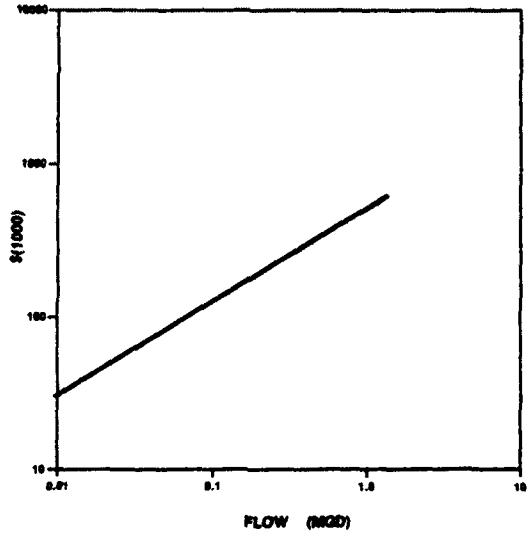


Figure VIII-16 TREATMENT COST CURVES
SLUDGE THICKENER

COMPONENTS INCLUDED

DIGESTION CHAMBER
AERATORS

CAPITAL COST



ANNUAL COST

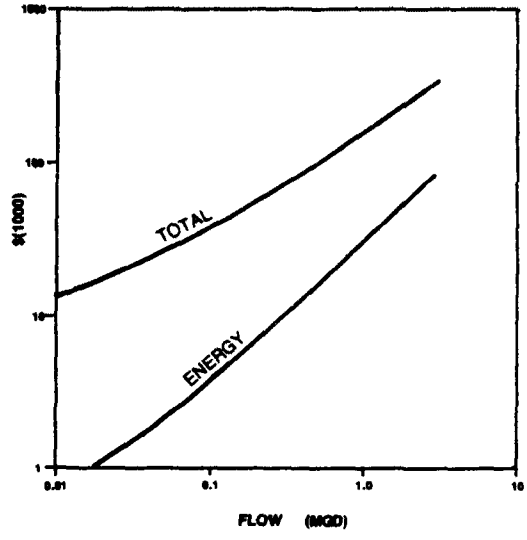
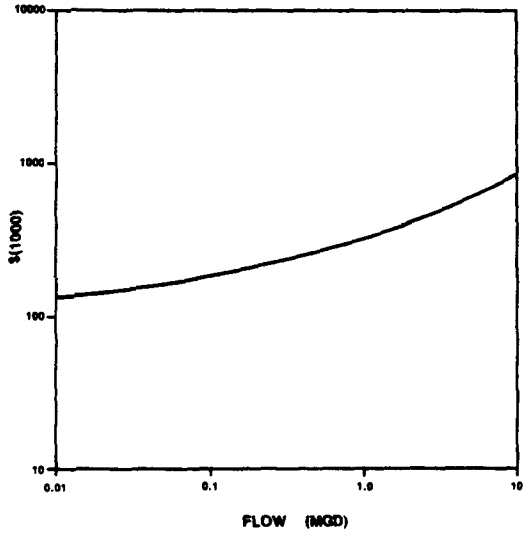


Figure VIII-17 TREATMENT COST CURVES
AEROBIC DIGESTION

COMPONENTS INCLUDED

VACUUM FILTER
CHEMICAL FEEDERS
CHEMICAL STORAGE

CAPITAL COST



ANNUAL COST

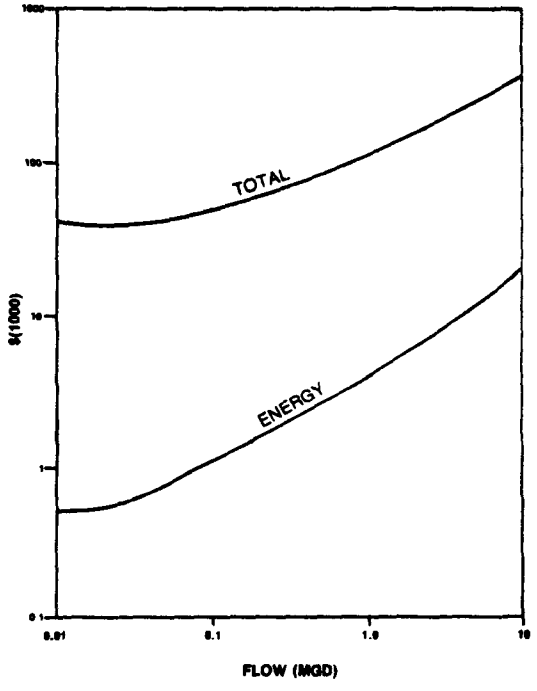
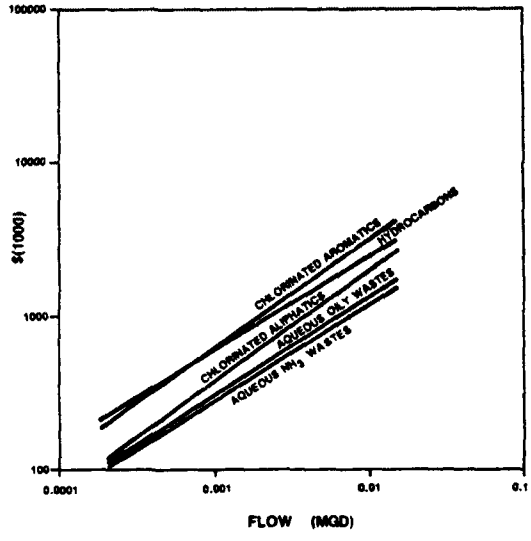


Figure VIII-18 TREATMENT COST CURVES
VACUUM FILTRATION

COMPONENTS INCLUDED

WASTEWATER STORAGE	AIR FAN
FUEL STORAGE	INCINERATOR
CAUSTIC STORAGE	VENTURI SCRUBBER
FEED PUMP	FINAL SCRUBBER
FUEL PUMP	HOLDING TANK
CAUSTIC ADDITION PUMP	pH ADJUSTMENT MIXING TANK
QUENCH PUMP	STACK

CAPITAL COST



ANNUAL COST

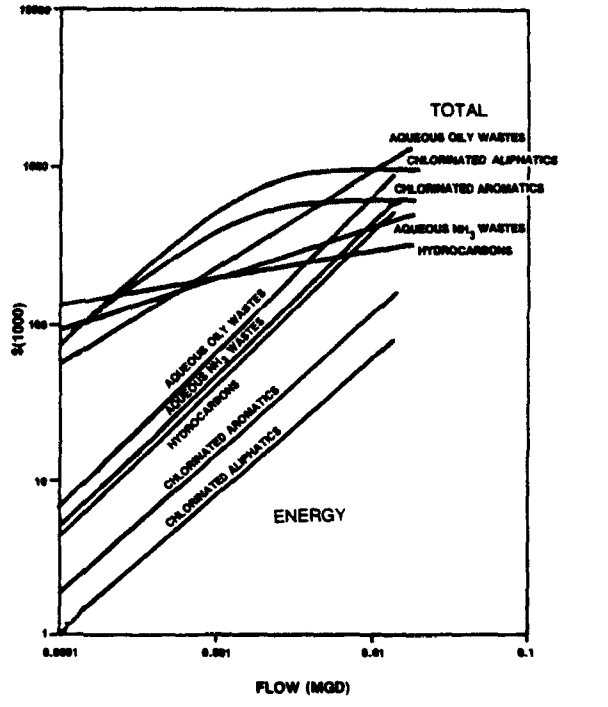
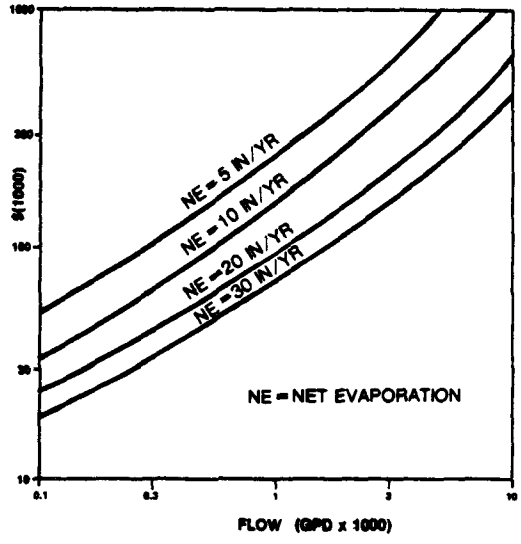


Figure VIII-19 TREATMENT COST CURVES
INCINERATION

COMPONENTS INCLUDED

LINED PONDS

CAPITAL COST



ANNUAL COST

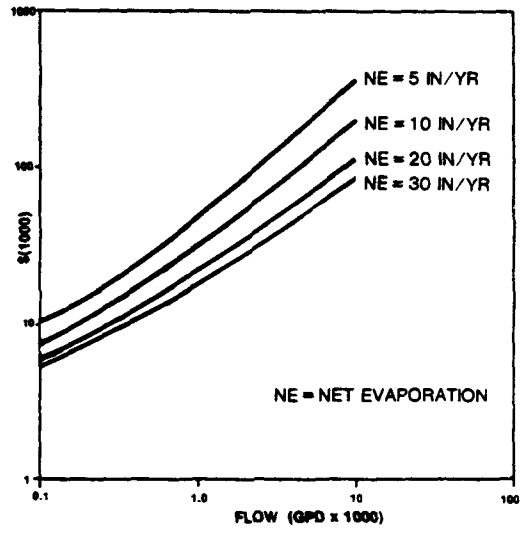
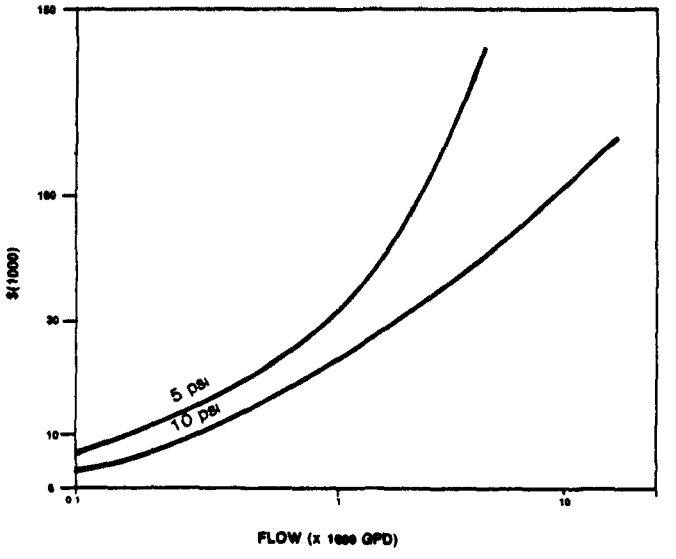


Figure VIII-20 TREATMENT COST CURVES
SOLAR EVAPORATION

COMPONENTS INCLUDED

LINED POND
PUMP
PIPE NETWORK INCLUDING NOZZLES

CAPITAL COST



ANNUAL COST

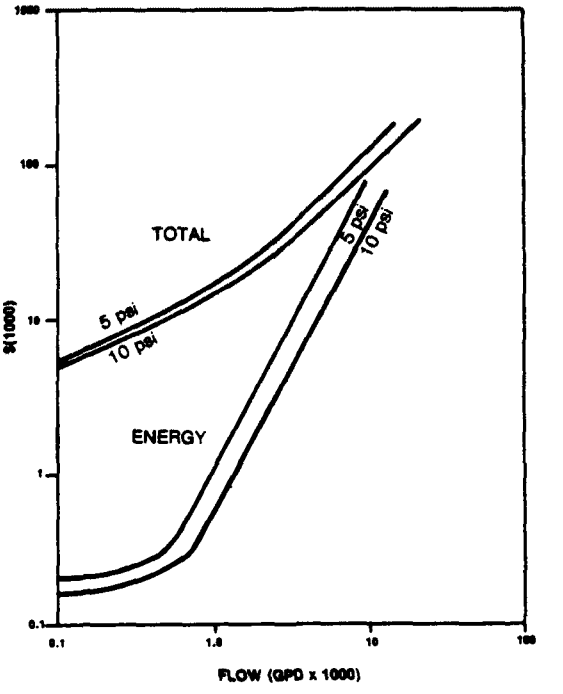


Figure VIII-21 TREATMENT COST CURVES
SPRAY EVAPORATION

SECTION IX

SELECTION OF POLLUTANT PARAMETERS PROPOSED FOR REGULATION

The purpose of this section is to define the pollutants proposed for regulation in the Pesticide Chemicals Industry and to provide the rationale for this proposal. EPA's objective was to limit the number of pollutants regulated to the minimum required to ensure compliance with the effluent levels technically achievable, while also reducing the possibility that discharges of wastewater would contribute to adverse effects on aquatic life or human health. The priority, nonconventional, and conventional pollutants in the scope of this study were segregated into the three groups defined below, as listed in Tables IX-1 through IX-3:

1. Pollutants of primary significance are those proposed to be regulated;

2. Pollutants of dual significance are proposed to be regulated only where they are the manufactured product; where they are a wastewater constituent of other pesticide products they are not regulated; and

3. Pollutants of secondary significance are not currently proposed for regulation; they are excluded.

The rationale for assigning pollutants into these three groups was based on factors such as raw waste load level and presence, treatability, analytical methods availability, and environmental effects.

Priority pollutants were initially categorized as being of primary or secondary significance, as shown in Tables IX-1 and IX-3, according to the rationale described below.

Priority pollutants detected or likely to be present in each pesticide wastestream were examined by group as shown in Section V, as was the raw waste load level. Priority pollutants were initially classified as of primary significance if:

1. They are shown to exist independently of other priority pollutants in that group, or

2. They are shown to exist in combination with other priority pollutants in that group; but because they may be raw materials, solvents, or products, they are normally found in higher concentrations than priority pollutants of secondary significance.

Priority pollutants were initially classified as of secondary significance if they lack adequate monitoring or can be adequately controlled by regulating the discharge of pollutants of primary significance to proposed levels because:

1. They were detected or are likely to exist predominantly in conjunction with pollutants of primary significance, or

2. They may be impurities or reaction byproducts that are normally found in lower concentrations than priority pollutants of primary significance.

In the manner described above, for example, benzene, toluene, and chlorobenzene were selected as priority pollutants of primary significance in the volatile aromatic pollutant group. Ethylbenzene was considered to be of secondary significance since it predominantly exists as an impurity in benzene or toluene. Hexachlorobenzene and 1,3-dichlorobenzene were considered to be of secondary significance since they predominantly exist in conjunction with, and at lower levels than, chlorobenzene.

Once the presence and levels of priority pollutants had been initially evaluated, the relative treatability of each priority pollutant was examined. The purpose of this review was to identify any priority pollutants initially classified as of secondary significance, which because of a lesser degree of treatability could not achieve the same effluent levels as priority pollutants of primary significance in the same pollutant group. Upon completion of this review it was concluded that the pollutants of primary significance represented the extremes of treatability in each group of priority pollutants and that no further additions were required.

Analytical methods availability was examined for the priority pollutants initially designated as of primary significance. It was judged that no modifications were required based on analytical methodology.

Finally, adverse effects on human health and aquatic life were evaluated for each pollutant under consideration. EPA Water Quality Criteria for each compound, if available, are cited in Tables IX-4 through IX-21. No changes to the initial classification of pollutants were required due to environmental effects.

All nonconventional pesticide pollutants with tentatively approved analytical procedures were categorized as of primary significance. These pollutants are identified in Sections XII and XIII. Nonconventional pesticide pollutants which lack approved analytical procedures and technical and economic data were categorized as of secondary significance and are proposed to be excluded from regulation at this time pending the development of analytical methods and the collection of an adequate data base. The pollutants ammonia and manganese have been detected at significant concentrations in segments of the pesticide industry but not across entire subcategories. Ammonia and manganese were classified as of secondary significance and national

limitations and standards are not proposed. Other nonconventional pollutants, excluding COD, were not considered for regulation in the Pesticide Industry.

The pollutants BOD, COD, TSS, and pH are considered to be of primary significance for this industry. Other conventional pollutants such as fecal coliform and oil and grease may be of concern in a particular location, but are generally considered of less importance. It is recommended that monitoring of these pollutants be considered on a plant-by-plant basis.

POLLUTANTS OF PRIMARY, DUAL, OR SECONDARY SIGNIFICANCE

Based upon the factors discussed above, it is proposed that the pollutants listed in Table IX-1 be considered of primary significance in the Pesticide Chemicals Industry.

The 29 priority pollutants listed in Table IX-1 will not necessarily be found in every pesticide plant's wastewater, and it is not proposed that each plant be regulated for all the priority pollutants of primary significance. The specific priority pollutants of primary significance proposed for regulation as a result of this study are listed by subcategory in Tables II-1 through II-43. A listing of all priority pollutants to be regulated in each pesticide wastewater is provided by pesticide in Section XXI--Appendix 9. This appendix, which provides manufacturers and EPA with a consolidated list of pollutants, can be verified and updated as more data become available.

It is proposed that the pollutants listed in Table IX-2 be considered of dual significance in the Pesticide Chemicals Industry. These pollutants (1,2-dichlorobenzene, 1,4-dichlorobenzene, 1,2,4-trichlorobenzene, bis (2-chloroethyl) ether, and 1,3-dichloropropene) are classified as pollutants of primary significance if they are manufactured as a pesticide product. If these pollutants are detected or likely to be present in other pesticide processes, they are classified as pollutants of secondary significance.

It is proposed that the pollutants listed in Table IX-3 be considered of secondary significance in the Pesticide Chemicals Industry. Pollutants of secondary significance which are proposed to be excluded from regulation include pollutants which lack adequate monitoring data or lack approved analytical methods. Pollutants of secondary significance which are proposed to be excluded from regulation include pollutants which were previously regulated, banned, not likely to be present in the industry, not likely to be present over the level of interest, or are judged to be adequately controlled if the pollutants of primary significance are reduced to proposed levels. Table IX-3 identifies pollutants which are proposed to be excluded from regulation.

A detailed discussion of the selection rationale for priority pollutants, nonconventional pollutants, and conventional pollutants is given as follows.

Priority Pollutants

Priority pollutants proposed as of primary, dual, or secondary significance are discussed by pollutant group in order of their approximate frequency of occurrence as follows.

Volatile Aromatics--

There are nine compounds which represent the volatile aromatic priority pollutant group. Wastewater analytical methods have been developed for all nine pollutants as shown in the December 1979 Federal Register. Benzene, chlorobenzene, and toluene were chosen as pollutants of primary significance since they are used as raw materials and solvents and are found in higher concentrations than the other volatile aromatic compounds. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the volatile aromatic compounds are presented in Table IX-4.

Primary Significance--In the pesticide industry, benzene is used as a raw material in the production of four pesticides. It is used as a solvent in at least 8 pesticide processes, and it is likely to be present in an additional 96 processes (primarily as an impurity in the solvent toluene). It has been detected in raw waste loads at concentrations up to 180,000 mg/l. While benzene in treated effluents has been observed for the most part to be less than 1 ppm, this level may have been achieved by volatilization in biological systems, thereby creating a potential air pollution problem. Benzene is toxic, carcinogenic, and a fire and explosive hazard (Centec, 1979; Kraybill, et al., 1979; U.S. EPA, 1979e). A 1972 environmental release potential of 183.6 million pounds has been reported by SRI (Centec, 1979).

In the pesticide industry, chlorobenzene is detected or likely to be present in 33 pesticide processes as a solvent, raw material, impurity, or final product. Of 21 processes monitored, chlorobenzene has been measured in raw waste loads at levels up to 979 mg/l.

In the pesticide industry, toluene is detected or likely to be present in 102 pesticide processes as a solvent, raw material, or impurity. Of 35 processes monitored, toluene concentrations in raw waste loads ranged from not detected to 294,000 mg/l. A 1972 environmental release potential of 1,074.2 million pounds, or 18 percent of the annual production, has been reported by SRI (Centec, 1979). Toluene is toxic by ingestion, inhalation, and skin absorption, and is a dangerous fire risk (Centec, 1979).

Dual Significance--In the pesticide industry, 1,2-dichlorobenzene is detected or likely to be present in 25 pesticide processes as a final product, raw material impurity, solvent impurity, or a reaction byproduct. Raw waste load concentrations of 1,2-dichlorobenzene have ranged up to 127 mg/l. It is an irritant and is moderately toxic by

ingestion and inhalation (Centec, 1979). 1,2-Dichlorobenzene is proposed for regulation as a priority pollutant only if it is manufactured as a product. In other processes it is expected to be adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

In the pesticide industry, 1,4-dichlorobenzene is detected or likely to be present in 26 pesticide processes as a final product, raw material impurity, or as a solvent impurity. Raw waste load concentrations of 1,4-dichlorobenzene have ranged up to 85.0 mg/l. 1,4-Dichlorobenzene is an eye irritant and is moderately toxic. It is estimated to have had an environmental release potential of 70.7 million pounds in 1972 which equates to 91 percent of the annual production (Centec, 1979). 1,4-Dichlorobenzene is proposed for regulation as a priority pollutant only if it is manufactured as a product. In other processes it is expected to be adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

In the pesticide industry, 1,2,4-trichlorobenzene is detected or likely to be present in 24 pesticide processes as a reaction byproduct, raw material impurity, or a stripper impurity. Raw waste load concentrations of 1,2,4-trichlorobenzene have ranged up to 36.0 mg/l. It is moderately toxic by ingestion and inhalation (Centec, 1979). 1,2,4-Trichlorobenzene is proposed for regulation as a priority pollutant only if it is manufactured as a product. In other processes it is expected to be adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

Secondary Significance--In the pesticide industry, 1,3-dichlorobenzene is detected or likely to be present in 26 pesticide processes as a raw material impurity, solvent impurity, or a reaction byproduct. Raw waste load concentrations of 1,3-dichlorobenzene have ranged up to 127 mg/l. 1,3-Dichlorobenzene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

In the pesticide industry, ethylbenzene is detected or likely to be present in 99 pesticide processes as a raw material, solvent impurity, or a raw material impurity. Raw waste load concentrations of ethylbenzene have ranged up to 7.9 mg/l. It is an eye and skin irritant, is moderately toxic by ingestion, inhalation, and skin absorption, and poses a dangerous fire risk. It is estimated to have had an environmental release potential of 203.5 million pounds in 1972, or the equivalent of one-third of the annual production (Centec, 1979). Ethylbenzene is expected to be adequately controlled by regulation of the priority pollutants of primary significance, benzene and toluene.

In the pesticide industry, hexachlorobenzene is detected or likely to be present in 18 pesticide processes as reaction byproducts, solvent impurity, or raw material impurity. Raw waste load concentrations of hexachlorobenzene have been detected at levels less than 0.008 mg/l. It is combustible and toxic (Centec, 1979). Hexachlorobenzene is expected

to be adequately controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

Halomethanes--

There are eight compounds which represent the halomethane priority pollutant group. Wastewater analytical methods have been developed for all eight pollutants as shown in the December 1979 Federal Register. Carbon tetrachloride, chloroform, methyl bromide, methyl chloride, and methylene chloride were chosen as pollutants of primary significance since they are used as raw materials and solvents and are found in higher concentration than the other halomethane compounds. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the halomethane compounds are presented in Table IX-5.

Primary Significance--In the pesticide industry, carbon tetrachloride is detected or likely to be present in 45 pesticide processes as a solvent, organic stripper solvent, solvent impurity, reaction byproduct, or raw material impurity. Carbon tetrachloride concentrations in raw waste loads have been detected at levels up to 121 mg/l. It is highly toxic by ingestion, inhalation, and skin absorption, and is a narcotic and is carcinogenic. It had an environmental release potential in 1972 of 715 million pounds or 71 percent of the annual production (Centec, 1979).

In the pesticide industry, methyl bromide (bromomethane) is detected or likely to be present in four pesticide processes as a final product, raw material, a reaction byproduct, or an impurity. Raw waste load concentrations have been monitored up to 2,600 mg/l. It is toxic by ingestion, inhalation, and skin absorption and is also a strong irritant to the skin.

In the pesticide industry, methyl chloride is detected or likely to be present in 48 pesticide processes as a solvent and organic stripper solvent, or as raw material, raw material impurity, or reaction byproduct. Methyl chloride has been monitored in only nine pesticide process raw waste loads with concentrations measured less than 1.0 mg/l. In 1972 it had an environmental release potential of 18.1 million pounds (Centec, 1979).

In the pesticide industry, methylene chloride is detected or likely to be present in 49 pesticide processes as a solvent, impurity, or reaction byproduct. Of 17 processes monitored, methylene chloride was detected in raw waste loads at concentrations equal to or less than 31,000 mg/l. A 1972 environmental release potential of 366.8 million pounds, or 78 percent of annual production, has been reported (Centec, 1979). Methylene chloride is moderately toxic by inhalation, ingestion, and skin absorption, and is an eye irritant (Centec, 1979).

Secondary Significance--In the pesticide industry, bromoform (tribromomethane) is detected or likely to be present in five

pesticide processes as either a reaction byproduct or as an impurity. Only trace levels were detected in the four processes monitored. Bromoform is toxic by ingestion, inhalation, and skin absorption (Centec, 1979), and is a potential mutagen (Kraybill, et al., 1979). Bromoform is expected to be adequately controlled by regulation of the priority pollutant of primary significance, methyl bromide.

In the pesticide industry, chlorodibromomethane is likely to be present in one pesticide process as a reaction byproduct. Raw waste load concentrations of chlorodibromomethane are not available in the pesticide industry. It is probably an irritant and narcotic (Centec, 1979) and is a suspected mutagen (Kraybill, et al., 1979). Chlorodibromomethane is expected to be adequately controlled by regulation of the priority pollutants of primary significance, methylene chloride and methyl bromide.

In the pesticide industry, dichlorobromomethane is detected or likely to be present in two pesticide processes as a reaction byproduct. The halomethane dichlorobromomethane is used as a fire extinguishing agent and/or propellant for fire extinguishers. It is also used as an additive to reduce tar formation in the production of polybutenylsuccinic anhydride (Centec, 1979). It is a suspected mutagen (Kraybill, et al., 1979). Dichlorobromomethane is expected to be adequately controlled by regulation of the priority pollutants of primary significance, methylene chloride and methyl bromide.

Cyanide--

Cyanide represents a priority pollutant group. Wastewater analytical methods have been developed for cyanide as described in the December 1979 Federal Register. Cyanide was chosen as a pollutant of primary significance since it is a unique compound in the pesticide industry where it is used as a raw material and is found in significant concentrations in pesticide raw waste loads. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for cyanide are presented in Table IX-6.

Primary Significance--In the pesticide industry, cyanide is detected or likely to be present in 25 pesticide processes as a raw material, impurity, or reaction byproduct. Of the 17 pesticide processes monitored, cyanide was present in levels ranging up to 5,503 mg/l in raw waste loads. Cyanide toxicity is essentially an inhibition of oxygen metabolism (U.S. EPA, 1976g).

Haloethers--

There are six compounds which represent the haloether priority pollutant group. Wastewater analytical methods have been developed for all six pollutants as shown in the December 1979 Federal Register. Since adequate monitoring data are not available, haloethers were not selected as pollutants of primary significance. However, bis(2-chloroethyl) ether has been classified as a pollutant of dual significance since it

is manufactured as a product and has zero wastewater discharge. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the haloether compounds are presented in Table IX-7.

Dual Significance--In the pesticide industry, bis(2-chlorethyl) ether (BCEE) is detected or likely to be present in 11 pesticide processes as a final product, reaction byproduct, or raw material impurity. BCEE has been detected in only one process raw waste load and was found at a concentration of 0.582 mg/l. It has been shown to be mutagenic and carcinogenic in laboratory animals (Kraybill, et al., 1979). Bis(2-chloroethyl) ether is proposed for regulation as a priority pollutant only if it is manufactured as a product. In other processes, coverage of BCEE is being excluded at this time until sampling programs can be instituted to confirm its presence as indicated by the process chemistry evaluation.

Secondary Significance--In the pesticide industry, bis(2-chloroethoxy) methane is likely to be present in eight pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in raw waste loads monitored. It is a strong irritant and is toxic by inhalation and ingestion (Centec, 1979). Bis(2-chloroethoxy) methane is proposed to be excluded from coverage pending the collection of adequate monitoring data.

In the pesticide industry, bis(2-chloroisopropyl) ether is likely to be present in 11 pesticide processes as a reaction byproduct or an impurity. This compound has not been detected in monitored raw waste loads. Bis(2-chloroisopropyl) ether is proposed to be excluded from coverage pending the collection of adequate monitoring data.

In the pesticide industry, 4-bromophenyl phenyl ether is likely to be present in one pesticide process as a reaction byproduct. This compound has not been monitored in the pesticide industry. In other industries 4-bromophenyl phenyl ether is used as a dielectric fluid, as a dye intermediate, and is used in the production of hypolipidemic agents (Centec, 1979). Coverage of this compound is proposed to be excluded until sampling programs can be instituted to confirm its presence as indicated by the process chemistry evaluation.

In the pesticide industry, 2-chloroethyl vinyl ether is likely to be present in 11 pesticide processes as a reaction byproduct or as an impurity. This compound has not been detected in the pesticide industry. It is moderately toxic by ingestion and inhalation and is a moderate fire and explosive hazard (Centec, 1979). 2-Chloroethyl vinyl ether is proposed to be excluded from coverage pending collection of adequate monitoring data.

In the pesticide industry, 4-chlorophenyl phenyl ether is likely to be present in 20 pesticide processes as a reaction byproduct. Raw waste load concentrations have not been detected in monitored waste streams. 4-Chlorophenyl phenyl ether is used as an antipyretic agent and

analgesic as well as a dielectric fluid for capacitors. This compound is proposed to be excluded from coverage pending the collection of adequate monitoring data.

Phenols--

There are 11 compounds which represent the phenol priority pollutant group. Wastewater analytical methods have been developed for all 11 pollutants as shown in the December 1979 Federal Register. 2,4-Dichlorophenol, 2,4-dinitrophenol, 4-nitrophenol, pentachlorophenol, and phenol were chosen as pollutants of primary significance since they are used as raw materials or produced as final products, and are found in higher concentrations than the other phenolic compounds. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the phenols are presented in Table IX-8.

Primary Significance--In the pesticide industry, 2,4-dichlorophenol is detected or likely to be present in 19 pesticide processes as a raw material, raw material impurity, or reaction byproduct. Of the 15 process raw waste loads monitored, the concentration of 2,4-dichlorophenol ranged from 0.042 mg/l to 42,000 mg/l.

In the pesticide industry, 2,4-dinitrophenol is detected or likely to be present in two pesticide processes as a raw material or raw material impurity. 2,4-Dinitrophenol concentrations in raw waste loads have been monitored at levels up to 7.91 mg/l. 2,4-Dinitrophenol is highly toxic and can be absorbed through the skin; dust inhalation can be fatal. In the dry form, 2,4-dinitropenol has a severe explosion hazard. The substance is known to cause cataract formation in humans and bacterial mutagenicity (U.S. EPA, 1979c).

In the pesticide industry, 4-nitrophenol is detected or likely to be present in four pesticide processes as a raw material or reaction byproduct. Of the three process raw waste loads monitored, 4-nitrophenol has been detected in raw waste streams with concentrations ranging from 0.002 mg/l to 461 mg/l.

In the pesticide industry, pentachlorophenol is detected or likely to be present in seven pesticide processes as a final product or reaction byproduct. Of two processes monitored, pentachlorophenol concentrations in raw waste loads ranged from 1.0 mg/l to greater than 1,000 mg/l. Pentachlorophenol is toxic by ingestion, inhalation, and skin absorption (Centec, 1979).

In the pesticide industry, phenol is detected or likely to be present in 23 pesticide processes as a raw material, impurity, or reaction byproduct. There have been ten processes monitored for phenol with concentrations ranging from 0.27 mg/l to 1,100 mg/l. Phenol is toxic by ingestion, inhalation, and skin absorption, and is a strong irritant to tissues. It has been estimated to have an environmental release potential in 1972 of 47 million pounds (Centec, 1979).

Secondary Significance--In the pesticide industry, 2-chlorophenol is detected or likely to be present in 14 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of 2-chlorophenol have been detected at levels less than 1,000 mg/l and at 30.5 mg/l. It is toxic by ingestion, inhalation, and skin absorption, and is a strong irritant (Centec, 1979). 2-Chlorophenol is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 2,4-dichlorophenol.

In the pesticide industry, 2,4-dimethylphenol is likely to be present in two pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. It is toxic by ingestion and skin absorption (Centec, 1979). 2,4-Dimethylphenol is expected to be adequately controlled by regulation of the priority pollutants of primary significance, 2,4-dichlorophenol and phenol.

The compound 4,6-dinitro-o-cresol is not likely to be present in the pesticide industry. It is highly phytotoxic. To humans, it is toxic and is absorbed by the skin (Centec, 1979). The presence of 4,6-dinitro-o-cresol, if any, would be expected to be adequately controlled by regulation of the priority pollutants of primary significance, 2,4-dichlorophenol and phenol.

In the pesticide industry, 2-nitrophenol is likely to be present in two pesticide processes as an impurity. Raw waste load concentrations have not been monitored in the pesticide industry. For the protection of freshwater aquatic life, EPA has proposed a limit of 6,200 ug/l (U.S. EPA, 1979c). 2-Nitrophenol is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 4-nitrophenol.

In the pesticide industry, parachlorometa cresol (4-chloro-m-cresol) is likely to be present in two pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. The presence of 4-chloro-m-cresol is expected to be adequately controlled by regulation of the priority pollutants of primary significance, 2,4-dichlorophenol and phenol.

In the pesticide industry, 2,4,6-trichlorophenol is detected or likely to be present in 14 pesticide processes as a reaction byproduct or as an impurity. Of the nine processes monitored, 2,4,6-trichlorophenol concentrations in raw waste loads ranged from 0.022 mg/l to 8,700 mg/l. 2,4,6-Trichlorophenol is expected to be adequately controlled by the regulation of the priority pollutant of primary significance, 2,4-dichlorophenol.

Nitrosubstituted Aromatics--

There are three compounds which represent the nitrosubstituted aromatic priority pollutant group. Wastewater analytical methods have been

developed for the three pollutants as shown in the December 1979 Federal Register. There are no pollutants of primary significance in this group since 2,4-dinitrotoluene, 2,6-dinitrotoluene, and nitrobenzene are expected to be adequately controlled by the regulation of a pollutant of primary significance. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water criteria for the nitrosubstituted aromatics are presented in Table IX-9.

Secondary Significance--In the pesticide industry, 2,4-dinitrotoluene is likely to be present in five pesticide processes as a reaction byproduct. This compound has not been monitored in the pesticide industry. It can be absorbed by the skin and is highly toxic and is a moderate fire and explosion hazard (Centec, 1979). The presence of 2,4-dinitrotoluene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, toluene.

In the pesticide industry, 2,6-dinitrotoluene is likely to be present in five pesticide processes as a reaction byproduct. The nitrosubstituted aromatic 2,6-dinitrotoluene is predominantly used as a mixture with 2,4-dinitrotoluene. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. The presence of 2,6-dinitrotoluene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, toluene.

In the pesticide industry, nitrobenzene is detected or likely to be present in 26 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have been detected in monitored waste streams at less than 0.01 mg/l. It is highly toxic by ingestion, inhalation, and skin absorption. It is estimated that nitrobenzene had an environmental release potential of 19.3 million pounds in 1972 (Centec, 1979). The presence of nitrobenzene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, benzene.

Polynuclear Aromatic Hydrocarbons--

There are 17 compounds which represent the polynuclear aromatic hydrocarbon (PNA) priority pollutant group. Wastewater analytical methods have been developed for all 17 pollutants as shown in the December 1979 Federal Register. Nine PNAs are not detected or likely to be present in the pesticide industry. Since adequate monitoring data are not available for the remaining eight compounds, polynuclear aromatic hydrocarbons were not selected as pollutants of primary significance and are therefore reserved from coverage at this time. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the polynuclear aromatic hydrocarbons are presented in Table IX-10.

Secondary Significance--In the pesticide industry, acenaphthylene is likely to be present in six pesticide processes as an impurity. Raw waste load concentrations of this compound have not been detected in

monitored waste streams. Acenaphthylene is proposed to be excluded from coverage pending the collection of adequate monitoring data.

In the pesticide industry, acenaphthene is likely to be present in six pesticide processes as an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams. Acenaphthene is proposed to be excluded from coverage pending the collection of adequate monitoring data.

In the pesticide industry, anthracene is likely to be present in six pesticide processes as an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams. Anthracene is carcinogenic (Centec, 1979). This compound is proposed to be excluded from coverage pending the collection of adequate monitoring data.

Benzo(a)anthracene is not detected or likely to be present in the pesticide industry. It is a potent carcinogen (Centec, 1979), having been found to affect the liver, lung, skin, and subcutaneous tissue in mice (Kraybill, et al.,1979).

Benzo(a)pyrene is not detected or likely to be present in the pesticide industry. It is toxic by inhalation and is one of the strongest carcinogens known to man (Centec, 1979). Benzo(a)pyrene has been found to cause cancer of the skin, lung, forestomach, subcutaneous tissue, and mammary gland in mice, rats, hamsters, rabbits, and monkeys (Kraybill, et al., 1979).

3,4-Benzofluoranthene is not detected or likely to be present in the pesticide industry.

Benzo(ghi)perylene is not detected or likely to be present in the pesticide industry. It is a suspected carcinogen thought to cause cancer of the skin in mice (Kraybill, et al., 1979).

Benzo(k)fluoranthene is not detected or likely to be present in the pesticide industry.

In the pesticide industry, 2-chloronaphthalene is detected or likely to be present in 18 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of 2-chloronaphthalene have been reported at less than 0.01 mg/l. The oil of chloronaphthalene is toxic by inhalation and is a strong irritant. The wax of 2-chloronaphthalene decomposes to form nitrosoamines (Centec, 1979). 2-Chloronaphthalene is proposed to be excluded from coverage pending the collection of adequate monitoring data.

Chrysene is not detected or likely to be present in the pesticide industry.

Dibenzo(a,h)anthracene is not detected or likely to be present in the pesticide industry. It has been found to cause cancer in the

forestomach, skin, lung, and subcutaneous tissue of mice and rats, and is a suspected mutagen (Kraybill, et al., 1979).

In the pesticide industry, fluoranthene is likely to be present in six pesticide processes as an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams. It is moderately toxic (Centec, 1979). Fluoranthene is proposed to be excluded from coverage pending the collection of adequate monitoring data.

In the pesticide industry, fluorene is likely to be present in six pesticide processes as an impurity. Raw waste load concentrations of fluorene have not been detected in monitored waste streams. Fluorene is proposed to be excluded from coverage pending the collection of adequate monitoring data.

Indeno(1,2,3-cd)pyrene is not detected or likely to be present in the pesticide industry. It is carcinogenic (Centec, 1979).

In the pesticide industry, naphthalene is detected or likely to be present in 25 pesticide processes as a reaction byproduct or as an impurity. Of the four processes monitored for naphthalene, levels were detected up to 1.06 mg/l. These data were determined to be insufficient on which to propose regulation. However, as shown in the process chemistry evaluation, naphthalene is indicated to be present in significant concentrations. Therefore, naphthalene is proposed to be excluded from regulation pending the collection of adequate monitoring data.

In the pesticide industry, phenanthrene is likely to be present in six pesticide processes as an impurity. Raw waste load concentrations have not been detected in monitored waste streams. Phenanthrene is carcinogenic (Centec, 1979). Phenanthrene is proposed to be excluded from coverage pending the collection of adequate monitoring data.

Pyrene is not detected or likely to be present in the pesticide industry. It is one of the most powerful carcinogens known (Centec, 1979) and is a suspected mutagen (Kraybill, et al., 1979).

Metals--

There are 13 compounds which represent the metals priority pollutant group. Wastewater analytical methods have been developed for all 13 pollutants as shown in the December 1979 Federal Register. Copper and zinc were chosen as pollutants of primary significance since they are detected or likely to exist in significant concentrations and are independent of other priority pollutants in this group. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the metals are presented in Table IX-11.

Primary Significance--In the pesticide industry, copper is detected or likely to be present in 11 pesticide processes as a raw material or

catalyst. Of six pesticide process raw waste loads monitored, copper was present at levels ranging from not detected to 59,000 mg/l. Copper is known to be toxic at high levels; however, the taste threshold concentration of 1 mg/l was used for the criteria of the Drinking Water Standard (U.S. EPA, 1979c).

In the pesticide industry, zinc is detected or likely to be present in 11 pesticide processes as a raw material, catalyst, or as an impurity. Of two processes monitored, zinc concentrations were detected in raw waste streams at a level of 247 mg/l. Although zinc is an essential and beneficial element in human metabolism (U.S. EPA, 1976g), the Drinking Water Standard of 5.0 mg/l has been set due to its undesirable aesthetic effects.

Secondary Significance--Antimony is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.1 mg/l. Although antimony is not considered a major environmental contaminant, it can be toxic to both aquatic and terrestrial organisms at high concentrations. It is known to cause chromatic breaks in human leukocyte cultures and is thus considered a potential carcinogen (Jett, 1980).

In the pesticide industry, arsenic is detected or likely to be present in one pesticide process as a raw material impurity. Raw waste load concentrations of arsenic have not been monitored for this pesticide; however, arsenic has been detected in significant concentrations in the treated effluent. In 1974, about 28.6 million pounds of arsenic was used by pesticide manufacturers in the United States. The use of these pesticides is estimated to have resulted in 80 to 90 percent of the total arsenic emissions (U.S. EPA, 1976h). Inorganic arsenic is absorbed readily from the gastrointestinal tract, lungs, and to a lesser extent from the skin, and becomes distributed throughout the body tissues and fluids (U.S. EPA, 1976g). In Formosa and Argentina, arsenic in drinking water has been implicated as causing cancer (Kraybill, et al., 1979). It should be noted that arsenic is not proposed for regulation as a priority pollutant of primary significance but is proposed to be excluded from coverage pending the collection of additional monitoring data.

Beryllium is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.05 mg/l. Beryllium is toxic by most routes of administration (U.S. EPA, 1976g) and has been correlated with bone, breast, and uterine cancer (Kraybill, et al., 1979).

Cadmium is not detected or likely to be present in pesticides industry in concentrations over the level of interest of 0.005 mg/l. Cadmium has a high toxic potential and is readily deposited and accumulated in various body tissues; virtually no absorbed cadmium is eliminated (U.S. EPA, 1976g).

Chromium is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.025 mg/l. For the protection of human health from the toxic properties of chromium (with the exception of hexavalent chromium), EPA has proposed a limit of 50 ug/l for the ingestion of water and contaminated aquatic organisms.

Lead is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.025 mg/l.

Mercury is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.001 mg/l.

In the pesticide industry, nickel is likely to be present in one pesticide process as a catalyst. Raw waste load concentrations have not been monitored in the pesticide industry; however, nickel is not likely to be present in concentrations over the level of interest of 0.5 mg/l. Nickel concentrations appear to correlate with mouth and intestinal cancer (Kraybill, et al., 1979). It is considered nontoxic to man (U.S. EPA, 1976g).

Selenium is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.01 mg/l.

Silver is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.005 mg/l.

Thallium is not detected or likely to be present in the pesticide industry in concentrations over the level of interest of 0.05 mg/l.

Chlorinated Ethanes and Ethylenes--

There are 12 compounds which represent the chlorinated ethanes and ethylenes priority pollutant group. Wastewater analytical methods have been developed for all 12 pollutants as shown in the December 1979 Federal Register. 1,2-Dichloroethane and tetrachloroethylene were chosen as pollutants of primary significance since they are used as solvents in the industry and are found in higher concentrations than the other compounds in this group. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentrations, and the human health water quality criteria for the chlorinated ethanes and ethylene compounds are presented in Table IX-12.

Primary Significance--In the pesticide industry, 1,2-dichloroethane is detected or likely to be present in 26 pesticide processes as a solvent, reaction byproduct, or as an impurity. Of the six process raw waste loads monitored, 1,2-dichloroethane concentrations were detected up to 10,000 mg/l. It was estimated to have an environmental release potential of 540.2 million pounds in 1972 (Centec, 1979). 1,2-Dichloroethane is known to be mutagenic and potentially carcinogenic (Kraybill, et al., 1979).

In the pesticide industry, tetrachloroethylene is detected or likely to be present in 15 pesticide processes as an impurity, reaction byproduct, or solvent. Of the four processes monitored, tetrachloroethylene concentrations in raw waste loads ranged from 0.37 mg/l to less than 98.0 mg/l. It is estimated that there was a 500-million-pound environmental release potential in 1972, or 68 percent of the annual production (Centec, 1979). Tetrachloroethylene is suspected of being carcinogenic (U.S. EPA, 1979e).

Secondary Significance--In the pesticide industry, chloroethane is likely to be present in 26 pesticide processes as a reaction byproduct or as an impurity. Raw waste load concentrations have not been detected in monitored waste streams. It is moderately toxic, an eye irritant, and is a severe fire and explosive risk (Centec, 1979). Chloroethane is reported to have had an environmental release potential of 34.5 million pounds in 1972 (Centec, 1979). The presence of chloroethane is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1-dichloroethane is likely to be present in 26 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams. It is moderately toxic and combustible. 1,1-Dichloroethane is expected to be adequately controlled by the regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1-dichloroethylene is likely to be present in 15 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations have not been detected in monitored waste streams. The priority pollutant 1,1-dichloroethylene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, hexachloroethane is likely to be present in seven pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have not been detected in monitored waste streams. Hexachloroethane is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1,2,2-tetrachloroethane is detected or likely to be present in 26 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have been detected at 1.70 mg/l in monitored waste streams. This compound is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,2-trans-dichloroethylene is likely to be present in 15 pesticide processes as a raw material or an impurity. Raw waste load concentrations have not been detected in monitored waste streams. 1,2-Trans-dichloroethylene is toxic by ingestion, inhalation,

and skin contact. It is estimated to have had an environmental release potential of 540.2 million pounds in 1972 (Centec, 1979). This compound is expected to be adequately controlled by regulation of the priority pollutant of primary significance, tetrachloroethylene.

In the pesticide industry, 1,1,1-trichloroethane is likely to be present in 26 pesticide processes as a reaction byproduct. Raw waste load concentrations have not been detected in monitored waste streams. It is estimated to have had an environmental release potential of 284.5 million pounds in 1972, which is 65 percent of the annual production (Centec, 1979). The presence of 1,1,1-trichloroethane is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, 1,1,2-trichloroethane is detected or likely to be present in 26 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have been detected in concentrations up to 0.02 mg/l in monitored waste streams. 1,1,2-Trichloroethane is expected to be adequately controlled by regulation of the priority pollutant of primary significance, 1,2-dichloroethane.

In the pesticide industry, trichloroethylene is detected or likely to be present in 15 pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations have ranged up to 0.052 mg/l. The presence of trichloroethylene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, tetrachloroethylene.

In the pesticide industry, vinyl chloride is likely to be present in 15 pesticide processes as a raw material, reaction byproduct, or as an impurity. Raw waste load concentrations have not been detected in monitored waste streams. It is highly flammable and a severe explosion hazard. Vinyl chloride was estimated to have an environmental release potential of 146.5 million pounds in 1972 (Centec, 1979). Vinyl chloride is expected to be adequately controlled by regulation of the priority pollutant of primary significance, tetrachloroethylene.

Nitrosamines--

There are three compounds which represent the nitrosamine priority pollutant group. Wastewater analytical methods have been developed for all three pollutants as shown in the December 1979 Federal Register. N-nitrosodi-n-propylamine was chosen as a pollutant of primary significance since it is found in higher concentrations than the other priority pollutant nitrosamines and, through monitoring, it is expected to adequately control N-nitrosodimethylamine and N-nitrosodiphenylamine. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the nitrosamines are presented in Table IX-13.

Primary Significance--In the pesticide industry, N-nitrosodi-n-propylamine is detected or likely to be present as a reaction byproduct in ten processes. Only one process has been monitored showing a maximum raw waste load concentration of 1.85 mg/l. N-nitrosodi-n-propylamine has been found to be carcinogenic (Centec, 1979).

Secondary Significance--In the pesticide industry, N-nitrosodimethylamine is detected or likely to be present in ten pesticide processes as a reaction byproduct. Raw waste load concentrations of this compound have been monitored at less than 0.00005 mg/l. It has been found to cause cancer in laboratory animals (Centec, 1979). N-nitrosodimethylamine is expected to be adequately controlled by regulation of the priority pollutant of primary significance, N-nitrosodi-n-propylamine.

In the pesticide industry, N-nitrosodiphenylamine is likely to be present in two pesticide processes as a reaction byproduct. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. It is thought to be carcinogenic (Centec, 1979). The presence of N-nitrosodiphenylamine is expected to be adequately controlled by regulation of the priority pollutant of primary significance, N-nitrosodi-n-propylamine.

Phthalate Esters--

There are six compounds which represent the phthalate ester priority pollutant group. Wastewater analytical methods have been developed for all six pollutants as shown in the December 1979 Federal Register. Two phthalate esters are not detected or likely to be present in the pesticide industry. Phthalate esters were chosen as pollutants of secondary significance due to the lack of adequate monitoring data. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and human health water quality for the phthalate esters are presented in Table IX-14.

Secondary Significance--Bis(2-ethylhexyl) phthalate is not likely to be present in the pesticide industry. In other industries it is widely used as a plasticizer for resins, elastomers, and paints. It is estimated to have had an environmental release potential in the United States of 441.6 million pounds in 1972, or 102 percent of the annual production (Centec, 1979).

In the pesticide industry, butyl benzyl phthalate is likely to be present in ten pesticide processes as a reaction byproduct or as an impurity. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. It is of low toxicity and is combustible (Centec, 1979). Butyl benzyl phthalate is proposed to be reserved from coverage until sampling programs can be instituted to confirm its presence as likely to be present by the process chemistry evaluation.

In the pesticide industry, dimethyl phthalate is likely to be present in ten pesticide processes as a raw material, reaction byproduct, or as

an impurity. Dimethyl phthalate has not been monitored in the pesticide industry. It is toxic by ingestion and inhalation and is an irritant (Centec, 1979). Coverage of dimethyl phthalate is proposed to be excluded until sampling programs can be instituted to confirm its presence as indicated by the process chemistry evaluation.

In the pesticide industry, diethyl phthalate is likely to be present in ten pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have not been detected in the pesticide industry. It is toxic by ingestion and inhalation and is a strong irritant to the eyes and mucous membranes. It is a narcotic at higher concentrations (Centec, 1979). Diethyl phthalate is proposed to be excluded from coverage pending the collection of adequate monitoring data.

Di-n-octyl phthalate is not likely to be present in the pesticide industry.

In the pesticide industry, di-n-butyl phthalate is likely to be present in ten pesticide processes as a reaction byproduct or an impurity. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. Di-n-butyl phthalate is proposed to be excluded from coverage until sampling programs can be instituted to confirm its presence as indicated by the process chemistry evaluation.

Dichloropropane and Dichloropropene--

There are two compounds which represent the dichloropropane and dichloropropene priority pollutant group. Wastewater analytical methods have been developed for both pollutants as shown in the December 1979 Federal Register. Since adequate monitoring data are not available, dichloropropane and dichloropropene were not selected as pollutants of primary significance. However, 1,3-dichloropropene has been classified as a pollutant of dual significance since it is manufactured as a final product and has zero wastewater discharge. The 1980 ambient water quality criteria, the lowest reported aquatic toxic concentration, and human health water quality criteria for dichloropropane and dichloropropene are presented in Table IX-15.

Dual Significance--In the pesticide industry, 1,3-dichloropropene is likely to be present in 12 pesticide processes as a raw material, solvent, reaction byproduct, or impurity. This compound has not been detected in either of the two pesticide raw waste loads monitored. 1,3-Dichloropropene is proposed for regulation as a priority pollutant only if it is manufactured as a final product. In other processes, coverage of 1,3-dichloropropene is proposed to be excluded at this time until sampling programs can be instituted to confirm its presence as indicated by the process chemistry evaluation.

Secondary Significance--In the pesticide industry, 1,2-dichloropropane is likely to be present in 12 pesticide processes as a raw

material, solvent, reaction byproduct, or impurity. 1,2-Dichloropropane was not detected in either of the two raw waste loads monitored. 1,2-Dichloropropane is toxic by ingestion and inhalation and is a dangerous fire risk (Centec, 1979). It is suspected of being a mutagenic (Kraybill, et al., 1979). Coverage of 1,2-dichloropropane is proposed to be excluded at this time pending the collection of adequate monitoring data.

Priority Pollutant Pesticides--

There are 18 compounds which represent the priority pollutant pesticide group. Wastewater analytical methods have been developed for all 18 pollutants as shown in the December 1979 Federal Register. BHC-alpha, BHC-beta, BHC-delta, endosulfan-alpha, endosulfan-beta, endrin, heptachlor, lindane, and toxaphene were chosen as pollutants of primary significance since they are produced as final products. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the priority pollutant pesticide compounds are presented in Table IX-16.

Primary Significance--In the pesticide industry, BHC-alpha is likely to be present in five pesticide processes as a final product or a reaction byproduct. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. It is toxic by ingestion, skin absorption, is an eye and skin irritant, and a central nervous system depressant (Centec, 1979). BHC was previously regulated during BPT for direct discharge only.

In the pesticide industry, BHC-beta is likely to be present in five pesticide processes as a final product or a reaction byproduct. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. It is moderately toxic by inhalation, highly toxic by ingestion, and is a strong irritant by skin absorption. It acts as a central nervous system depressant (Centec, 1979). BHC was previously regulated during BPT for direct discharge only.

In the pesticide industry, BHC-delta is likely to be present in five pesticide processes as a final product or a reaction byproduct. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. It is moderately toxic by inhalation and highly toxic by ingestion. It is a strong irritant to the skin and eyes, is absorbed by the skin, and is a central nervous system depressant (Centec, 1979). BHC was previously regulated during BPT for direct discharge only.

In the pesticide industry, endosulfan-alpha is likely to be present in one pesticide process as a final product. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. Endosulfan was regulated during BPT for direct discharge only.

In the pesticide industry, endosulfan-beta is likely to be present in one pesticide process as a final product. Raw waste load concentrations have not been monitored in the pesticide industry. Endosulfan is toxic by ingestion, inhalation, and skin absorption (Centec, 1979). Endosulfan was regulated during BPT for direct discharge only.

In the pesticide industry, endrin is used as a final product in one pesticide process. It has been monitored in the raw waste load at a level which is declared proprietary. It is highly toxic by inhalation and skin absorption (Centec, 1979). Endrin is proposed as a pollutant of primary significance because its discharge has been regulated for direct discharge only (U.S. EPA, 1977h).

In the pesticide industry, heptachlor is detected or likely to be present in two pesticide processes as a final product or reaction byproduct. Raw waste load concentrations of heptachlor have ranged up to a declared proprietary level. Heptachlor is a nonsystemic stomach and contact insecticide which has fumigant action. It is a soft waxy solid with a melting range of 46 to 74°C and is practically insoluble in water (Martin and Worthing, 1977). Heptachlor is very toxic to mammals with an acute oral LD50 of 100 mg/kg for male rats and an acute dermal LD50 for male rats of 195 mg/kg (Martin and Worthing, 1977). Heptachlor and its epoxide bioaccumulate in fatty tissue and persist for lengthy periods of time. Several uses of heptachlor have been discontinued to avoid contamination of milk and animal products (Vettorazzi, 1979). Heptachlor is a suspected carcinogen (Kraybill, 1977). The total number of tumors in both male and female rats increased in one long-term study after heptachlor exposure (Vettorazzi, 1979). It has been recommended that human daily intake of heptachlor should not exceed 0.005 mg/kg of body weight (Vettorazzi, 1979). A ban was placed on heptachlor in Canada in 1969 because of concern for residues in milk and deleterious effects on birds (McEwen and Stephenson, 1979).

In the pesticide industry, lindane (BHC-gamma) is likely to be present in two pesticide processes as a final product or a reaction byproduct. Raw waste load concentrations of this compound have not been monitored in the pesticide industry. It is highly toxic by ingestion and moderately toxic by inhalation (Centec, 1979). BHC was previously regulated during BPT for direct discharge only.

In the pesticide industry, toxaphene is used as a final product in one pesticide process. Toxaphene concentrations in raw waste loads have been detected at levels which are declared proprietary. Toxaphene is proposed as a pollutant of primary significance because its discharge has been regulated for direct discharge only (U.S. EPA, 1977h).

Secondary Significance--In the pesticide industry, aldrin is detected or likely to be present in one pesticide process as a reaction byproduct. Raw waste load concentrations of aldrin have been monitored at a level which is declared proprietary. It is highly toxic by ingestion and inhalation, and is absorbed through the skin. It has been found to be carcinogenic to the liver of mice. For the protection

of human health against the carcinogenic properties of aldrin, EPA has proposed a limit of 4.6×10^{-3} ng/l at a risk factor of 10^{-6} for the ingestion of water and contaminated aquatic organisms. Aldrin is expected to be adequately controlled by regulation of the priority pollutant endrin. Additionally, the pesticide aldrin was previously regulated under Section 307(a), and is banned from manufacture and use by EPA.

In the pesticide industry, chlordane is likely to be present in two pesticide processes as a final product or a reaction byproduct. Chlordane has not been detected in the pesticide industry. Chlordane was the first known cyclodiene insecticide. It is a contact and stomach poison used mainly as a soil insecticide (McEwen and Stephenson, 1979). Chlordane is a viscous, amber-colored liquid which is insoluble in water. The vapor pressure is 1×10^{-5} torr at 25°C (Martin and Worthing, 1977). The acute oral LD50 is 457 to 590 mg/kg (Martin and Worthing, 1977) and the dermal LD50 is 80 mg/kg for rats (McEwen and Stephenson, 1979; Martin, 1977). Long-term studies show that chlordane causes hepatocellular carcinomas in mice at 60 mg/kg (Vettorazzi, 1979). Chlordane is highly persistent in the soil. As an example, one study reported that 16 percent of a 14 kg/ha application remained after 15 years. Residues in root crops have been detected up to four years after application to the soil (McEwen and Stephenson, 1979). A toxic metabolite of chlordane, oxychlordane, is stored in the fat and/or excreted in the milk of mammals. Man's intake of chlordane is recommended not to exceed 0.001 mg/kg (Vettorazzi, 1979). It is toxic by ingestion, inhalation, skin absorption (Centec, 1979), and is a suspected mutagen (Kraybill, et al., 1979). Chlordane was previously regulated during BPT for direct discharge only. Coverage of chlordane in these regulations is proposed to be excluded at this time pending the collection of adequate monitoring data.

In the pesticide industry, dieldrin is detected or likely to be present in one pesticide process as a reaction byproduct. Raw waste load concentrations of this compound have been monitored at levels which are declared proprietary. It is highly toxic by ingestion, inhalation, and skin absorption (Centec, 1979). Dieldrin has been found to cause cancer in the liver of mice (Kraybill, et al., 1979). Dieldrin is expected to be adequately controlled by regulation of the priority pollutant endrin. Additionally, the pesticide dieldrin was previously regulated under Section 307(a), and is banned from manufacture and use by EPA.

In the pesticide industry, 4,4'-DDD is detected or likely to be present in five pesticide processes as a final product or a reaction byproduct. Raw waste load concentrations of 4,4'-DDD have been monitored at levels which are declared proprietary. It is toxic by ingestion, inhalation, skin absorption, and is combustible. The use of DDD is restricted in the United States (Centec, 1979). The presence of 4,4'-DDD is expected to be adequately controlled by regulation of the pesticide methoxychlor, the only currently manufactured source. Additionally, discharge from the pesticide DDD has been prohibited (U.S. EPA, 1977h).

In the pesticide industry, 4,4'-DDE is detected or likely to be present in five pesticide processes as a final product or a reaction byproduct. Raw waste load concentrations of 4,4'-DDE have been monitored at levels which are declared proprietary. DDE is significantly more stable than DDT and results in more serious consequences than DDT (Centec, 1979). Evidence exists to suggest that it causes cancer of the liver in mice (Kraybill, et al., 1979). The presence of this compound is expected to be adequately controlled by regulation of the pesticide methoxychlor, the only currently manufactured source. Additionally, discharge from the pesticide DDE has been prohibited (U.S. EPA, 1977h).

In the pesticide industry, 4,4'-DDT (DDT) is detected or likely to be present in five pesticide processes as a final product, raw material, or reaction byproduct. DDT concentrations in solid wastes being contract hauled have been monitored at levels which are declared proprietary. DDT is not proposed as a pollutant of primary significance because its discharge has been prohibited (U.S. EPA, 1977h).

In the pesticide industry, endosulfan sulfate is likely to be present in one pesticide process as a reaction byproduct. Raw wasteload concentrations of this compound have not been monitored in the pesticide industry. It is toxic and has no known commercial uses (Centec, 1979). Endosulfan sulfate is expected to be adequately controlled by the regulation of the priority pollutant, endosulfan.

In the pesticide industry, endrin aldehyde is likely to be present in one pesticide process as a reaction byproduct. Raw waste load concentrations of this compound have been monitored in the pesticide industry at levels which are declared proprietary. It is toxic and has no known commercial uses (Centec, 1979). Information concerning the fate of the compound is sparce (SRI International, 1979). The presence of endrin aldehyde is expected to be adequately controlled by regulation of the priority pollutant, endrin.

In the pesticide industry, heptachlor epoxide is likely to be present in two pesticide processes as a reaction byproduct. Raw waste load concentrations have been monitored in waste streams at levels which are declared proprietary. It is toxic (Centec, 1979) and has been found to cause cancer in the liver of mice (Kraybill, et al., 1979). Heptachlor epoxide is expected to be adequately controlled by regulation of the priority pollutant of primary significance, heptachlor.

Dienes--

There are two compounds which represent the diene priority pollutant group. Wastewater analytical methods have been developed for both compounds as described in the December 1979 Federal Register. Hexachlorocyclopentadiene was chosen as a pollutant of primary significance since it is used as a raw material and is found in higher concentrations than hexachlorobutadiene. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the diene compounds are presented in Table IX-17.

Primary Significance--In the pesticide industry, hexachlorocyclopentadiene (HCCPD) is detected or likely to be present in six pesticide processes as a raw material. HCCPD concentrations in raw waste loads range from 0.435 mg/l to 2,500 mg/l. It is toxic by inhalation, ingestion, and skin absorption (Centec, 1979).

Secondary Significance--In the pesticide industry, hexachlorobutadiene is detected or likely to be present in eight pesticide processes as a solvent, reaction byproduct, or an impurity. Raw waste load concentrations have ranged up to 0.191 mg/l. Hexachlorobutadiene is expected to be adequately controlled by regulation of the priority pollutant of primary significance, hexachlorocyclopentadiene.

TCDD--

TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin) represents a priority pollutant group. A wastewater analytical method has been developed for TCDD as described in the December 1979 Federal Register. TCDD was chosen as a pollutant of secondary significance since adequate monitoring and control data have not been developed. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for TCDD are presented in Table IX-18.

Secondary Significance--In the pesticide industry, 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) is detected or likely to be present in 11 pesticide processes as a reaction byproduct. TCDD has been monitored in one raw waste load at a concentration of 0.022 mg/l. It is extremely toxic and a potential carcinogen and mutagen. Coverage of TCDD is proposed to be excluded at this time pending the collection of adequate monitoring and control data.

Miscellaneous Priority Pollutants--

There are five compounds which represent the miscellaneous priority pollutant group. Wastewater analytical methods have been developed for all five pollutants as shown in the December 1979 Federal Register. All five compounds have been chosen as pollutants of secondary significance since they lack adequate monitoring data or they are not detected or likely to be present in this industry. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the miscellaneous priority pollutant group are presented in Table IX-19.

Secondary Significance--The compound acrolein is not detected or likely to be present in the pesticide industry. It is toxic and a very strong irritant. It is the active ingredient in tear gas.

The compound acrylonitrile is detected or likely to be present in one pesticide process. It is toxic by inhalation and skin absorption and is flammable. It is estimated to have had an environmental release potential of 27.4 million pounds in 1972 (Centec, 1979). Coverage of

acrylonitrile is proposed to be excluded at this time pending the collection of adequate monitoring data.

In the pesticide industry, asbestos is detected to be present in 72 pesticide/nonpesticide wastewaters. Raw waste load concentrations have ranged from nondetectable limits to 0.3 mg/l (total calculated mass chrysotile fibers only). These concentrations are not shown to be process related, and are therefore not proposed for regulation as a pollutant of primary significance.

The compound 1,2-diphenylhydrazine is not detected or likely to be present in the pesticide industry. It has been found to cause cancer in the liver, mammary glands, urinary tract, and skin of mice and rats (Kraybill, et al., 1979).

The compound isophorone is not detected or likely to be present in the pesticide industry.

Polychlorinated Biphenyls--

Seven polychlorinated biphenyls (PCBs) represent a priority pollutant group. Wastewater analytical methods have been developed for PCBs as shown in the December 1979 Federal Register. PCBs were chosen as pollutants of secondary significance since they are not currently likely to be present in the pesticide industry. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the PCBs are presented in Table IX-20.

Secondary Significance--In the pesticide industry, PCBs are likely to be present in one pesticide process as reaction byproducts. No data are available on the concentration of PCBs in the raw waste loads of this pesticide process. Since this pesticide is not currently manufactured, PCBs are not proposed for regulation as a pollutant of primary significance.

Benzidines--

There are two compounds which represent the benzidine priority pollutant group. Wastewater analytical methods have been developed for both compounds as described in the December 1979 Federal Register. Benzidine and 3,3'-dichlorobenzidine were chosen as pollutants of secondary significance since they are not likely to be present in the pesticide industry. The 1980 EPA ambient water quality criteria, the lowest reported aquatic toxic concentration, and the human health water quality criteria for the benzidines are presented in Table IX-21.

Secondary Significance--The compound benzidine is not likely to be present in the pesticide industry. In other industries it is primarily used in the manufacture of dyes and other organic synthesis processes. Other uses include rubber vulcanization (Centec, 1979). Benzidine is a

potential mutagenic (Kraybill, et al., 1979), carcinogenic, and is toxic by ingestion, inhalation, and skin absorption (Centec, 1979).

The compound 3,3'-dichlorobenzidine is not likely to be present in the pesticide industry.

Nonconventional Pesticide Pollutants

Nonconventional pesticide pollutants are proposed for regulation, provided that technical and economic data and acceptable analytical methods are available for pesticide active ingredients as listed in Table XII-1. A generalized rationale for their selection as pollutants of primary significance is given below; however, a detailed discussion of the deleterious effects of each specific pesticide on humans and the environment is subsequently provided in alphabetical order for 137 pesticides with approved analytical procedures.

Pesticides are, by their very nature and use, toxic to certain living organisms. They can be a hazard to aquatic life, terrestrial life, and man when allowed to enter the natural environment in sufficient amounts. Pesticides may affect the aquatic environment and water quality in several ways. A pesticide with a slow rate of degradation will persist in the environment, suppressing or destroying some organism populations while allowing others to gain supremacy resulting in an imbalance in the ecosystem. Other pesticides will degrade rapidly, some to products that are more toxic than the parent compound, some to relatively harmless products, and some to products for which toxicity data are lacking. Many pesticides have a high potential for bioaccumulation and biomagnification in the aquatic and terrestrial food chains, thereby posing a serious threat to a large number of ecologically important organisms, including humans (FWPCA, 1968).

The chlorinated hydrocarbons are among the most widely used groups of synthetic organic pesticides. They are stable in the environment, toxic to wildlife and nontarget organisms, and have adverse physiological effects on humans. These pesticides readily accumulate in aquatic organisms and in man. They are stored in fatty tissue and are not rapidly metabolized. Humans may accumulate chlorinated hydrocarbon residues by direct ingestion of contaminated water or by consumption of contaminated organisms. Regardless of how chlorinated hydrocarbons enter organisms, they induce poisoning having similar symptoms that differ in severity. The severity is related to the extent and concentration of the compound in the nervous system, primarily the brain. Deleterious effects on human health are also suspected to result from long-term, low-level exposure to this class of compounds (FWPCA, 1968).

The organo-phosphorus pesticide chemicals typically hydrolyze or break down into less toxic products more rapidly than the halogenated compounds. Generally, they persist for less than a year; however, some last for only a few days in the environment. They exhibit a wide range of toxicity, both more and less damaging to aquatic fauna than the chlorinated hydrocarbons. Some exhibit a high mammalian toxicity.

Accumulation of some of these pesticides results in a dysfunction of the cholinesterase of the nervous system when ingested in small quantities over a long period of time (FWPCA, 1968).

The organo-nitrogen pesticide chemicals are also generally less persistent in the environment than the chlorinated hydrocarbons. They exhibit a wide range of toxicity. The carbamates are particularly toxic to mammals. They appear to act on the nervous system in the same manner as the organo-phosphorus pesticides.

Pesticides which are not classified as pollutants of primary significance are considered to be of secondary significance due to the lack of analytical methods and/or data availability.

Primary Significance--Alachlor has been monitored in raw waste loads at declared proprietary concentrations. It is a selective pre-emergence herbicide (Martin and Worthing, 1977). Inhibition of growth in the shoots and roots of germinating seedlings is known to occur in the presence of alachlor (McEwen and Stephenson, 1979). Alachlor has a melting point of 40°C to 41°C. Its solubility in water is 240 mg/1 at 23°C (Martin and Worthing, 1977). The acute oral LD50 for rats is 1,200 mg/kg; and a dermally applied lethal dose is 2,000 mg/kg (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (rainbow trout; freshwater) is 1.0 mg/1 at 96 hours (U.S. EPA, 19741). The acute LC50 for the bluegill is 4.3 mg/1 at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for alachlor is 28 (Kenaga, 1979). Alachlor has a residual action lasting 10 weeks to 12 weeks (Martin and Worthing, 1977).

Alkylamine hydrochloride has not been monitored in the pesticide industry. The LC50 for the most sensitive organism reported (bluegill; freshwater) was 0.064 mg/1 at 96 hours (U.S. EPA, OPP).

Ametryne has been monitored in raw waste loads at declared proprietary levels. It is used as a pre- and post-emergence selective herbicide for the control of broad-leaved and grassy weeds in pineapple, sugar cane, banana, citrus, corn, and coffee crops. Ametryne forms colorless crystals with a melting point of 84 to 86°C and vapor pressure of 8.4×10^{-7} torr at 20°C. Its solubility in water is 185 mg/1 at 20°C (Martin and Worthing, 1977). The acute dermal LD50 for rabbits is greater than 8,160 mg/kg. The acute oral LD50 is 935 mg/kg to 965 mg/kg for mice and 1,405 mg/kg for rats. Rats fed 100 mg/kg/day for 90 days showed slight histological changes in the liver (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (rainbow trout; freshwater) is 3.2 mg/1 at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the bluegill is 3.7 mg/1 (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for ametryne is 33 (Kenaga, 1979).

Aminocarb has not been monitored in the pesticide industry. It is a nonsystemic insecticide with acaricidal and molluscicidal activity. It is used against biting insects, mites, and slugs. Aminocarb is a white

crystalline solid with a melting point of 93°C to 94°C, and is only slightly soluble in water (Martin and Worthing, 1977). Aminocarb is extremely toxic to mammals. The acute oral LD50 is 30 mg/kg for rats. The acute intraperitoneal and dermal LD50s for rats are 21 mg/kg and 175 mg/kg, respectively. Aminocarb is highly toxic to honey bees (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (Walleye; freshwater) is 0.880 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50 value for the bluegill is 3.1 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). For the rainbow trout the LC50 is 5.7 mg/l at 96 hours (Segna, 1981).

Amoban has not been monitored in the pesticide industry. Amobam is a trade name for the diammonium salt of Nabam in a 4-percent solution (Martin and Worthing, 1977) (see Nabam for additional environmental and health effects). Amoban showed positive results in testing for carcinogenicity (NIOSH, 1977). The LD50 for rats is 395 mg/kg (Segna, 1981).

Raw waste load concentrations of AOP have been monitored at levels which are declared proprietary. AOP is a protective fungicide which, when applied to the soil, has systemic action.

Atrazine has been detected in raw waste loads at concentrations declared proprietary. It is used as a selective pre- and post-emergence herbicide on a variety of crops including maize, sorghum, sugar cane, and pineapple. It is used in water treatment against algae and submerged plants (Martin and Worthing, 1977). Atrazine is a colorless crystal with a melting point of 175°C to 177°C and a vapor pressure of 3.0×10^{-7} torr at 20°C. Its solubility in water is 28 mg/l at 20°C (Martin and Worthing, 1977). Its acute oral LD50 is 1,750 mg/kg for mice and 3,080 mg/kg for rats. The acute dermal LD50 for rabbits is 7,500 mg/kg. The acute LC50 for the most sensitive organism reported (Catfish; freshwater) is 0.22 mg/l (Piecuch, 1981). The acute LC50 for the bluegill is 15 mg/l at 96 hours (Piecuch, 1979). The acute LC50 for the rainbow trout is 4.5 mg/l at 96 hours (Segna, 1981). The predicted BCF value for atrazine is 86 (Kenaga, 1979). Aquatic life toxicity is found at 35 mg/l for the carp and 5.30 mg/l for the trout (Ludemann and Kayser, 1965). Toxic levels for the fry of the fish Coreganus fera are as low as 3 ppm (Little, 1980). In Daphnia magna and Maina rectorostrisis, increases of embryonic and post-embryonic development from over 30 days to 45 days have been noted at 1 ppm (Scherban, 1973). The half-life for atrazine in soil is 26 weeks to 78 weeks (Little, 1980), and it may absorb by clays such as montmorillonite (Little, 1980). The LD50 for fish is considered to be 12.6 mg/l (Little, 1980). It was found in low toxicity in tests on rainbow trout and bluegills (Martin and Worthing, 1977). The general use and persistent nature of atrazine present the possibility for contamination of ground waters that are drinking water sources for much of the rural population of North America (McEwen and Stephenson, 1979). Traces of atrazine have been found in finished water in Iowa cities obtaining their supply from wells and in higher levels in those supplied from surface waters (McEwen and Stephenson, 1979).

Azinphos methyl has been monitored in raw waste loads at concentrations declared proprietary. It is a nonsystemic insecticide and acaricide (Martin and Worthing, 1977). It is used against foliage-feeding insects and has broad spectrum effects (McEwen and Stephenson, 1979). Azinphos methyl is a white crystal with a melting point of 73°C to 74°C. Its solubility in water is 33 mg/l at room temperature. It is rapidly hydrolyzed by cold alkali and acid (Martin and Worthing, 1977). The acute LD50 is 4 ppb for brown trout and 5 ppb for largemouth bass. Fish kills have resulted from contamination of azinphos methyl by its use in vegetable and fruit production (McEwen and Stephenson, 1979). Azinphos methyl has high mammalian toxicity. The acute oral LD50 for female rats is 16.4 mg/kg (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (Gammorus; saltwater) is 0.00015 mg/l at 96 hours (Segna, 1981). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.022 mg/l and 0.0043 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). Four million pounds of azinphos methyl were produced in the United States in 1971. Estimated agricultural use for this same year was 2.7 million pounds (McEwen and Stephenson, 1979). In the United States, a 24-hour reentry interval has been established between the application of azinphos methyl and the time workers may reenter a field (McEwen and Stephenson, 1979). Persistence in the environment is long, lasting 2 or more weeks (McEwen and Stephenson, 1979).

Barban has not been monitored in the pesticide industry. It is a selective post-emergence herbicide used for the control of wild oats. It is a crystalline solid with a melting point of 75°C to 76°C. Its solubility in water is 11 mg/l at 25°C (Martin and Worthing, 1977). The acute oral LD50 for rats and mice is 1,300 mg/kg to 1,500 mg/kg, and the dermal LD50 for rats is 1,600 mg/kg. It has been recommended that skin contact be avoided by humans to protect against allergic reactions (Martin and Worthing, 1977).

BBTAC has not been monitored in the pesticide industry, and information on environmental and health effects was not available at time of publication.

Benfluralin has not been monitored in the pesticide industry. When incorporated into the soil, benfluralin acts as a pre-emergence herbicide for the control of annual grasses and broad-leaved weeds in lettuce, tobacco, and other forage crops (Martin and Worthing, 1977). Benfluralin is a yellow-orange crystalline solid with a melting point of 65° to 66.5°C. Its solubility in water is less than 1 mg/l at 25°C. The acute oral LD50 for rabbits, dogs, and chickens is greater than 2,000 mg/kg. It is of low to moderate persistence in the environment (Martin and Worthing, 1977). The acute EC50 for the most sensitive organism reported (Gammorus; saltwater) is 1.1 mg/l at 48 hours (U.S. EPA, OPP).

Benomyl has not been monitored in raw waste loads in the pesticide industry. It is a protective and eradicant fungicide with systemic activity used on a wide range of fungi in fruits, nuts, vegetables, and

ornamentals. It is a white crystalline solid with a faint acrid odor. At 20°C its solubility in water is 3.8 mg/l (Martin and Worthing, 1977). Benomyl acts in a manner similar to colchicine, and its fungicidal action is effected by adsorption to spindle fibers involved in cell division. The LD50 for Daphnia magna (an aquatic vertebrate) is 0.64 ppm (McEwen and Stephenson, 1979). The acute oral LD50 for rats is greater than 10,000 mg/kg. The LC50 for mallard ducks and quail is greater than 5,000 mg/kg. Benomyl is highly toxic to earthworms. The acute LC50 for the most sensitive organism reported (catfish; freshwater) is 0.029 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.46 mg/l and 0.17 mg/l, respectively, at 96 hours (Segna, 1981).

Raw waste load concentrations of bentazon have been monitored at levels which are declared proprietary. Bentazon, a contact herbicide, is used for control of Matricaria, Anthemis spp., and other plants in winter and spring cereals. It is ineffective as a pre-emergence herbicide since it is absorbed by leaves, and it has little effect on germinating seeds (Martin and Worthing, 1977). Bentazon is a white odorless crystalline powder with a melting point of 137°C to 139°C. Its solubility in water is 500 mg/kg (Martin and Worthing, 1977). For rats, the acute oral LD50 is 1,100 mg/kg, and the dermal LD50 is greater than 2,500 mg/kg. Application caused severe eye irritation in rabbits (Martin and Worthing, 1977). The predicted BCF value for bentazon is 19 (Kenaga, 1979).

Biphenyl has not been monitored in the pesticide industry. It is a fungistatic agent used on citrus fruits during transportation and storage. Biphenyl is in the form of colorless leaflets, and its fungistatic properties are dependent upon the vapor it produces. Because it is not effective after it is absorbed by the fruit, concentrations of biphenyl must be maintained throughout the period of transport and storage (McEwen and Stephenson, 1979). Biphenyl is practically insoluble in water (Martin and Worthing, 1977). The acute oral LD50 is 3,280 mg/kg for rats. Prolonged exposure to human beings of vapor concentrations greater than 0.005 mg/l is considered dangerous (Martin and Worthing, 1977). Because persons of low resistance, including children and ill people, may consume a large amount of citrus fruit, higher safety factors were used in extrapolating toxicity parameters from animal data (McEwen and Stephenson, 1979). The acute LC50s for the bluegill and rainbow trout (freshwater) are 14.70 mg/l and 1.85 mg/l, respectively, at 96 hours (Segna, 1981). The calculated BCF value for biphenyl is 340 (Kenaga, 1979).

Raw waste load concentrations of bolstar have been monitored at declared proprietary levels. Bolstar is an insecticide. The oral LD50 is 65 mg/kg for rats by body weight (Segna, 1981). The skin LD50 for the rabbit is 820 mg/kg (NIOSH, 1977). The acute LC50s for the bluegill and rainbow trout (freshwater) are 1.0 mg/l and 29.7 mg/l, respectively, at 96 hours (Segna, 1981).

Raw waste load concentrations of bromacil have been monitored at levels which are declared proprietary. Bromacil is recommended for general

weed control on noncrop land such as railroad rights-of-way. It is a nonselective inhibitor of photosynthesis and is absorbed mainly through roots. It is also used for annual weed control in established citrus and pineapple plantations. Bromacil is a white crystalline solid with a melting point of 158°C to 159°C. Its solubility in water is 815 mg/l at 25°C (Martin and Worthing, 1977). The acute oral LD50 for rats is 5,200 mg/kg. The TLM (48-hour) for bluegill, sunfish, and rainbow trout is 70 mg/l to 75 mg/l (Martin and Worthing, 1977). The average half-life of bromacil is several months, and moderate mobility in the soil has been observed (McEwen and Stephenson, 1979).

Busan 40 has not been monitored in the pesticide industry, and information on environmental and health effects was limited at time of publication. The acute oral LD50 is 590 mg/kg for rats (Segna, 1981).

Busan 85 has not been monitored in the pesticide industry. It is a fungicide. The acute oral LD50 is 250 mg/kg for rats (Segna, 1981). The intraperitoneal LD50 for mice is 350 mg/kg (NIOSH, 1977).

Butachlor has been detected in raw waste loads in concentrations declared proprietary. It is a pre-emergence herbicide used in the control of annual grasses and certain broad-leaved weeds in rice. It is a light yellow oil with a boiling point of 196°C. Its solubility in water is 20 mg/l at 20°C (Martin and Worthing, 1977). The acute oral LD50 is 3,300 mg/kg for rats, and the dermal LD50 for rabbits is 4,000 mg/l. Butachlor is a skin and eye irritant (Martin and Worthing, 1977). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.072 mg/l and 4.5 mg/l, respectively, at 96 hours (Segna, 1981).

Captan has not been monitored in the pesticide industry. It is a nonsystemic fungicide used mainly for foliage protection. The technical product is an amorphous solid, white to beige in color with a pungent odor. Its melting point is 160°C to 170°C (Martin and Worthing, 1977). The acute oral LD50 is 9,000 mg/kg for rats. Captan may cause skin irritation (Martin and Worthing, 1977). In the environment, captan decomposition produces hydrochloric acid and its rapid hydrolysis can lead to toxic effects on sensitive plants (McEwen and Stephenson, 1979). Under alkaline conditions, captan produces hydrogen sulfide gas. Captan is of relatively long persistence in the environment (Vettorazzi, 1979). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.072 mg/l and 4.5 mg/l, respectively, at 96 hours (Segna, 1981). Captan showed positive results in testing for carcinogenicity (NIOSH, 1979). The predicted BCF value for captan is greater than 910 (Kenaga, 1979).

Carbam-S has not been monitored in the pesticide industry. Carbam-S is a soil fungicide. Information on environmental and health effects were not available at time of publication.

Carbaryl has not been monitored in the pesticide industry. It is a broad spectrum contact insecticide with slight systemic properties. Carbaryl is used extensively for foliar pests in agriculture, pests in

home gardens and lawns, and ectoparasites (fleas and ticks) on livestock and pets (McEwen, 1979; Martin, 1977). Carbaryl is a white crystalline solid with a melting point of 142°C. Its solubility in water is 40 mg/l at 30°C (Martin and Worthing, 1977). The acute oral LD50 for male rats is 850 mg/kg, and the acute dermal LD50 is 2,000 mg/kg for rabbits. It has been reported that in several animal species carbaryl has adverse effects on reproductive physiology. An increased ratio of urinary amino acid to creatinine resulted in man after exposure. Studies have indicated disturbance in the thyroid gland after short-term treatment, whereas long-term treatment resulted in disturbances of carbohydrate and protein metabolism, liver function, and endocrine function. A study of rats with low survival rates demonstrated that carbaryl produced sarcomas following its oral administration. Carbaryl can react with nitrate under mildly acidic conditions, such as in the human stomach, to produce N-nitrosocarbaryl, which is a proven carcinogen in rats (Vettorazzi, 1979). More than 44 million pounds of carbaryl were produced in the United States in 1971, 18 million pounds of which were used in American agriculture (McEwen and Stephenson, 1979). The acute LC50 for the most sensitive organism reported (Pteronarcella; saltwater) is 0.0017 mg/l (U.S. Fish and Wildlife Service, 1980). The acute LC50s for the bluegill and rainbow trout (freshwater) are 6.76 mg/l and 1.95 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). Carbaryl is suspected of being carcinogenic (NIOSH, 1979). The predicted BCF value for carbaryl is 77 (Kenaga, 1979).

Carbendazim concentrations in raw waste loads have been monitored at levels which are declared proprietary. Carbendazim is a broad-spectrum systemic fungicide and is absorbed by the roots and the green tissue of plants. It is a light grey powder with a solubility in water of 5.8 mg/l at 20°C (Martin and Worthing, 1977). The acute oral LD50 for dogs is more than 2,500 mg/kg, and the acute dermal LD50 for rats is more than 2,000 mg/kg (Martin and Worthing, 1977). In studies of mice and rats, carbendazim caused testicular damage to males (Vettorazzi, 1979).

Carbofuran concentrations in raw waste loads have been monitored at levels which are declared proprietary. Carbofuran is a broad-spectrum, systemic insecticide, acaricide, and nematicide. It is a white, odorless, crystalline solid with a solubility in water of 700 mg/l at 25°C (Martin and Worthing, 1977). The TLM (96-hour) for trout is 0.8 mg/l. Carbofuran is highly toxic to mammals. The acute LD50 is 8 mg/kg to 14 mg/kg for rats and the acute dermal LD50 for rabbits is 3,400 mg/kg (Martin and Worthing, 1977). As the preceding toxicity parameters show, carbofuran is highly toxic by several routes. Carbofuran is metabolized to oxidative products which are only slightly less toxic than the parent compound. High levels administered to test animals affect reproductive activity (Vettorazzi, 1979). The half life of carbofuran in the soil ranges from 30 days to 80 days (McEwen and Stephenson, 1979). The acute LC50 for the most sensitive organisms reported (bluegill; freshwater) is 0.08 mg/l at 96 hours (Piecuch, 1974). The acute LC50 for the rainbow trout (freshwater) is 0.38 mg/l

at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for carbofuran is 21 (Kenaga, 1979).

Carbophenothion concentrations in raw waste loads have been monitored at levels which are declared proprietary. It is a nonsystemic insecticide and acaricide used for preharvest treatments on deciduous and citrus fruits. It is also used as seed dressing for cereal grains (Vettorazzi, 1979). It is an off-white to amber-colored liquid with a mild mercaptan-like odor. Its boiling point is 82°C and it is soluble in water at the rate of 40 mg/l (Martin and Worthing, 1977). The acute oral LD50 for male albino rats is 32.3 mg/kg, and the acute dermal LD50 is 1,270 mg/kg for rabbits. Carbophenothion is toxic to honey bees (Martin and Worthing, 1977). Several instances of geese poisoning have been reported. The poisoning occurred while geese were foraging in fields planted with carbophenothion-treated seed. Analysis of the dead birds revealed that death was caused by organophosphate poisoning. The LD50 for Canadian geese is 29 to 35 mg/kg (McEwen and Stephenson, 1979). The acute LC50 for the most sensitive organism reported (Palaemonetes; saltwater) is 0.0012 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50 for the bluegill (freshwater) is 0.013 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for carbophenothion is 1,140 (Kenaga, 1979).

Chlorobenzilate concentrations in raw waste loads have been monitored at declared proprietary levels. Chlorobenzilate is a nonsystemic acaricide, of little insecticidal action, used for the control of mites on citrus and deciduous fruit. It is a pale yellow solid with a melting point of 35°C to 37°C and a boiling point of 156°C to 158°C. The technical product is a brownish liquid of approximately 96 percent purity and is practically insoluble in water (Martin and Worthing, 1977). The acute oral LD50 for rats ranges from 700 mg/kg to 3,100 mg/kg. The acute dermal LD50 is greater than 5,000 mg/kg for rabbits. Chlorobenzilate administered by the oral route produced an increased incidence of hepatomas in males. It has been recommended that man's daily intake of chlorobenzilate should not exceed 0.02 mg/kg (Vettorazzi, 1979). The acute EC50 for the most sensitive organism reported (Simolephalus; saltwater) is 0.6 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50 for the bluegill (freshwater) is 1.8 mg/l at 96 hours (Segna, 1981). The acute LC50 for the rainbow trout (freshwater) is 0.7 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). Chlorobenzilate was shown to have positive carcinogenicity test results (NIOSH, 1979).

Raw waste load concentrations of chloropicrin have been detected in the pesticide industry at values which are declared proprietary. Chloropicrin is an insecticide used as a fumigant on stored grain and for soil treatment against nematodes. It is a colorless liquid with a boiling point of 112.4°C. Its solubility in water is 2.27 g/l at 0°C (Martin and Worthing, 1977). Chloropicrin is lachrymatory (causing tears) and highly toxic. At 0.8 mg/l of air it causes coughing, vomiting, and suffocation and is lethal in 30 minutes (Martin and Worthing, 1977). A concentration of 2.4 g/m^3 can cause death in man from acute

pulmonary edema (Vettorazzi, 1979). The acute oral LD50 is 250 mg/kg for rats (Segna, 1981). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.105 mg/l and 0.016 mg/l, respectively, at 96 hours (Segna, 1981).

Chlorpropham has not been monitored in the pesticide industry. It is a selective pre-emergence herbicide and mitotic poison. It has been generally used to prevent potato sprouting (Martin and Worthing, 1977). Its solubility in water at 25°C is 89 mg/l, and its melting point is from 38.5°C to 40°C. In an acid or alkaline media chlorpropham will slowly hydrolyze, although it is stable below 100°C (Martin and Worthing, 1977). Since chlorpropham is derived from ethylurethane, a recognized carcinogen, it is also suspected to be carcinogenic. Studies on the skin of rats have shown it to be weak in tumor initiating activity (Vettorazzi, 1979). The acute oral LD50 for rats is 5,000 mg/kg to 7,500 mg/kg (Martin and Worthing, 1977). The acute LC50 for the bluegill (freshwater) is 8.0 mg/l at 96 hours (EPA, OPP). The predicted BCF value for chlorpropham is 50 (Kenaga, 1979).

Chlorpyrifos has not been monitored in the pesticide industry. It is a broad spectrum insecticide and is effective by contact, ingestion, and vapor action. It is used for the control of larvae and adult mosquitos, soils, and foliar crop pests, and for ectoparasites on sheep and cattle (Martin and Worthing, 1977; McEwen and Stephenson, 1979). The acute oral LD50 is 135 mg/kg for female rats and 32 mg/kg for chicks. The acute dermal LD50 for rabbits is 2,000 mg/kg. Chlorpyrifos is toxic to fish and shrimp (Martin and Worthing, 1977). It has been recommended that the daily intake for man should not exceed 0.001 mg/kg (Vettorazzi, 1979). Chlorpyrifos persists in the soil for 2 months to 4 months (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (G. lacustris; saltwater) is 0.00011 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.0024 mg/l and 0.0071 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The calculated BCF value for chlorpyrifos is 450 (Kenaga, 1979).

Chlorpyrifos methyl has not been monitored in the pesticide industry. It has a broad range of activity against insects and is effective by contact, ingestion, and vapor action. Chlorpyrifos methyl is used on stored grains foliar crop pests. Its form is white crystals with a slight mercaptan odor and a melting point of 45.5°C to 46.5°C. Its solubility in water is 4 mg/l at 25°C (Martin and Worthing, 1977). The acute oral LD50 for female rats is 1,630 mg/kg, and the acute dermal LD50 for rabbits is greater than 2,000 mg/kg. Chlorpyrifos methyl is toxic to shrimp (Martin and Worthing, 1977). It has been recommended that man's daily intake of chlorpyrifos methyl should not exceed 0.01 mg/kg (Vettorazzi, 1979). The predicted BCF value for chlorpyrifos methyl is 280 (Kenaga, 1979).

Coumaphos concentrations in raw waste loads have been detected at declared proprietary levels. Coumaphos is a contact and systemic insecticide used on animals, including poultry. Application is made by

dipping, spraying, adding to feed, and dusting. Based on short-term studies it is recommended that man's daily intake of coumaphos should not exceed 0.0005 mg/kg (Vettorazzi, 1979). The acute LC50 for the most sensitive organism reported (G. fasciatus; saltwater) is 0.000074 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.340 mg/l and 0.890 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Raw waste load concentrations of cyanazine have been monitored at levels which are declared proprietary. Cyanazine is a pre- and post-emergence herbicide used for general weed control. It is a white crystalline solid with a melting point of 166.5°C and solubility in water of 171 mg/l (Martin and Worthing, 1977). The acute LD50 for rats is 182 mg/kg, and the acute dermal LD50 is 1,200 mg/kg for rats. The oral LD50 is 750 mg/kg for chickens and 400 mg/kg to 500 mg/kg for quail. The TLM (48-hour) for the fish Rasbora is 10 mg/l (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (G. fasciatus, saltwater) is 2.0 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980).

Raw waste load concentrations of 2,4-D have been monitored at levels which are declared proprietary. 2,4-D along with its salts and esters are systemic herbicides used for the weeding of cereals and other crops. It is a white powder with a slight phenolic odor. 2,4-D has a melting point of 140.5°C, and its solubility in water is 620 mg/l at 25°C (Martin and Worthing, 1977). The acute oral LD50 of 2,4-D is 375 mg/kg for rats (Martin and Worthing, 1977). It has been recommended that man's daily intake of 2,4-D should not exceed 0.3 mg/kg (Vettorazzi, 1979). In the cells of plants, 2,4-D disrupts the normal metabolism of DNA, RNA, and protein as shown by twisted, coiled, or sharply bent developing stems. Actual plant death occurs when the xylem and/or phloem tissues are crushed by abnormal growth of the stems (McEwen and Stephenson, 1979). 2,4-D persists in the soil for at least 1 month (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (cutthroat trout; freshwater) is 0.9 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50s for the bluegill and rainbow trout (freshwater) are 7.5 mg/l and 2.0 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for 2,4-D is 13 (Kenaga, 1979). 2,4-D is suspected of having carcinogenic effects (NIOSH, 1979).

2,4-D isobutyl ester concentrations in raw waste loads have been monitored at declared proprietary levels. See 2,4-D for environmental and health effects.

2,4-D isooctyl ester has not been monitored in the pesticide industry. See 2,4-D for environmental and health effects.

2,4-D salt has not been monitored in the pesticide industry. See 2,4-D for environmental and health effects.

Raw waste load concentrations of 2,4-DB have been monitored at levels which are declared proprietary. 2,4-DB is a translocatable herbicide of similar effect to 2,4-D. It is more selective because its activity depends on oxidation to 2,4-D by the plant. It is used on lucerne, undersown cereals, and grasslands. The acute oral LD50 of 2,4-DB is 700 mg/kg for rats (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 16.8 mg/l and 14.3 mg/l, respectively, at 96 hours (EPA, OPP).

2,4-DB isobutyl ester has not been monitored in the pesticide industry. See 2,4-DB for environmental and health effects.

2,4-DB isooctyl ester has not been monitored in the pesticide industry. See 2,4-DB for environmental and health effects.

DBCP (dibromochloropropane) has not been monitored in the pesticide industry. DBCP is a soil fumigant used in the control of nematodes. It is an amber to dark brown liquid with a mildly pungent odor and a boiling point of 196°C. Its solubility in water is 1 g/kg at room temperature (Martin and Worthing, 1977). The acute oral LD50 for rats is 170 mg/kg to 300 mg/kg. The acute dermal LD50 is 1,420 mg/kg for rabbits. The TLM (24-hour) is 30 mg/l to 50 mg/l for bass and 50 mg/l to 125 mg/l for sunfish (Martin and Worthing, 1977). DBCP is persistent in the soil, thereby requiring a long aeration time before planting such crops as potatoes and tobacco (Martin and Worthing, 1977). The acute LC50 for the rainbow trout (freshwater) is 36.5 mg/l at 96 hours (EPA, OPP). DBCP showed positive test results for carcinogenicity (NIOSH, 1979). The predicted BCF value for DBCP is 11 (Kenaga, 1979).

DCNA (dichloran) has not been monitored in raw waste loads in the pesticide industry. DCNA is a protectant fungicide which is used for foliar application and soil treatment. During preharvest it is used on vegetables and cotton, while at post harvest it is used as a dip for peaches, nectarines, and carrots (Vettorazzi, 1979). It is a yellow odorless crystalline solid with a melting point of 195°C. DCNA is practically insoluble in water (Martin and Worthing, 1977). The acute oral LD50 is between 1,500 mg/kg and 4,000 mg/kg for several species (Martin and Worthing, 1977). Dogs fed DCNA have been known to develop cataracts when exposed to sunlight. Feeding studies of dogs and rats resulted in growth retardation accompanied by an increased liver and kidney size (Vettorazzi, 1979). It has been recommended that man's daily intake of DCNA should not exceed 0.03 mg/kg (Vettorazzi, 1979). The acute LC50 for the rainbow trout (freshwater) is 0.56 mg/l at 96 hours (EPA, OPP).

D-D has not been monitored in the pesticide industry. D-D is a pre-plant nematicide. It is a clear amber liquid with a pungent odor and is soluble in water of 2 g/kg at room temperature (Martin and Worthing, 1977). The mixture is highly pytotoxic, and the usual application usage is 75 liters of D-D per hectare. In wet or cold conditions, a longer interval should be allowed (Martin and Worthing, 1977). The acute oral LD50 is 140 mg/kg for rats. The acute dermal

LD50 is 2,100 mg/kg for rabbits. It is a known irritant to human skin (Martin and Worthing, 1977).

Raw waste load concentrations of deet have been monitored at levels which are declared proprietary. Deet is an insect repellent which is effective against mosquitoes. It is a colorless to amber liquid with a boiling point of 111°C. Deet is practically insoluble in water (Martin and Worthing, 1977). The acute oral LD50 for male albino rats is 2,000 mg/kg. Daily applications to human face and arms can cause irritation (Martin and Worthing, 1977). The acute LC50 for the rainbow trout (freshwater) is 75.0 mg/l at 96 hours (EPA, OPP).

Raw waste load concentrations of demeton have been monitored at levels which are declared proprietary. Demeton is a systemic insecticide and acaricide which has some fumigant action. It rapidly penetrates plants and is effective against sap-feeding insects and mites. Demeton is a colorless oil with a boiling point of 123°C. Its solubility in water is 60 mg/l at room temperature (Martin and Worthing, 1977). The acute oral LD50 of demeton is 2.5 mg/l to 4 mg/kg for female rats (Martin and Worthing, 1977). Man's daily intake of demeton should not exceed 0.005 mg/kg (Vettorazzi, 1979). The acute LC50 for the most sensitive organism reported (Daphnia, saltwater) is 0.014 mg/l at 96 hours (Segna, 1981). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.133 mg/l and 0.14 mg/l to 0.21 mg/l, respectively, at 96 hours (Segna, 1981).

Demeton-o has not been monitored in the pesticide industry. Demeton-o is a systemic insecticide and acaricide which has some fumigant action. It is a colorless oil with a boiling point of 123°C. Its solubility in water is 60 mg/l at room temperature. The acute oral LD50 of demeton-o is 30 mg/kg for male rats (Martin and Worthing, 1977).

Demeton-s has not been monitored in the pesticide industry. Demeton-s is a systemic insecticide and acaricide which has some fumigant action. It is a colorless oil with a boiling point of 128°C. Its solubility in water is 2 g/l at room temperature. The acute oral LD50 of demeton-s is 1.5 mg/kg (Martin and Worthing, 1977).

Raw waste load concentrations of diazinon have been monitored at levels which are declared proprietary. Diazinon is a nonsystemic insecticide and acaricide used on rice, sugar cane, corn, tobacco, and potatoes. It is a pale to dark brown liquid with a solubility in water of 40 mg/l. Traces of water in diazinon promote hydrolysis of diazinon to the highly poisonous compound tetraethyl monothiopyrophosphate (Martin and Worthing, 1977). The acute oral LD50 for rats is 66 mg/kg to 600 mg/kg. The acute dermal LD50 is 379 mg/kg to 1,200 mg/kg. The presence of low levels of diazinon in water have caused lethal and sublethal effects on fish and aquatic invertebrates. Diazinon persists on plants for 7 days to 10 days (McEwen and Stephenson, 1979). It has been recommended that man's daily intake of diazinon should not exceed 0.002 mg/kg of body weight (Vettorazzi, 1979). The acute LC50 for the most sensitive organism reported (G. fasciatus; saltwater) is 0.00020 mg/l at 96 hours

(U.S. Fish and Wildlife Service, 1980). The acute LC50s for the bluegill and rainbow trout (freshwater) are 0.168 mg/l and 0.090 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The calculated BCF value for diazinon is 35 (Kenaga, 1979).

Dicamba has not been monitored in raw waste loads in the pesticide industry. Dicamba is a post-emergence, translocateable herbicide used for weed control in cereals. The pure compound is a white crystalline solid with a melting point of 114° to 116°C. Its solubility in water is 4.5 g/l at 25°C. The technical acid is a pale buff crystalline solid of about 83 percent to 97 percent purity (Martin and Worthing, 1977). The TLMs (96-hour) are 23 mg/l for bluegills and 28 mg/l for rainbow trout. The acute oral LD50 is 2,900 mg/kg for rats (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (Daphnia, saltwater) is 20.0 mg/l at 96 hours (Segna, 1981). The acute LC50s for the bluegill and rainbow trout (freshwater) are greater than 50 mg/l and 28 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for dicamba is 5 (Kenaga, 1979).

Raw waste load concentrations of dichlofenthion have been monitored at levels which are declared proprietary. Dichlofenthion is a nonsystemic insecticide and nematicide which is applied to the soil. It is a colorless liquid with a boiling point of 120° to 123°C. Its solubility in water is 0.245 mg/l at 25°C. The technical product is 95 percent to 97 percent pure (Martin and Worthing, 1977). The acute oral LD50 is 270 mg/kg for male albino rats. The acute dermal LD50 is 6,000 mg/kg for rabbits (Martin and Worthing, 1977). The acute LC50 for the most sensitive organism reported (Pteronarcys; saltwater) is 0.0041 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The acute LC50s for the bluegill and rainbow trout (freshwater) are 1.230 mg/l and 1.250 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for dichlofenthion is 5 (Kenaga, 1979).

Dichlorophen salt has not been monitored in the pesticide industry. Dichlorophen salt is the sodium salt form of dichlorophen. Dichlorophen is a fungicide and bactericide used in the protection of materials from molds and algae. It is also employed in combating tapeworm infestation in man and animals as well as being a component in an athlete's foot preparation. Its solubility in water is 30 mg/l at 25°C and its melting point is at least 164°C. For guinea pigs the acute oral LD50 is 1,250 mg/kg and for dogs it is 2,000 mg/kg (Martin and Worthing, 1977). The acute LC50s for the bluegill and rainbow trout (freshwater) are 3.9 mg/l and 5.5 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Dichlorvos has been detected in raw waste loads in the pesticide industry at values which are declared proprietary. It is a contact and stomach insecticide which has penetrant and fumigant action. Dichlorvos is used on crops and as a household and public health fumigant. It is a colorless to amber liquid with an aromatic odor and has a boiling point of 35°C and is soluble in water at room temperature at the rate of 10 g/l (Martin and Worthing, 1977). The acute oral LD50 is 56 mg/kg for

female rats and the acute dermal LD50 for female rats is 75 mg/kg. The TLM (24-hour) for bluegills is 1 mg/l. Dichlorvos is known to be toxic to honey bees. The four-hour inhalation LC50 for mice is 13.2 mg/m^3 (Martin and Worthing, 1977). It has been recommended that man's daily intake of dichlorvos should not exceed 0.004 mg/kg (Vettorazzi, 1979). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.00007 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the bluegill (freshwater) is 0.869 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for dichlorvos is 3 (Kenaga, 1979).

Raw waste load concentrations of dicofol have been monitored at levels which are declared proprietary. Dicofol is a nonsystemic acaricide which has little insecticidal activity. It is used to control mites on a wide range of crops. The technical product is a brown viscous oil which is practically insoluble in water (Martin and Worthing, 1977). The acute oral LD50 for female rats is 684 ± 16 mg/kg of body weight. The acute dermal LD50 is 1,870 mg/kg for rabbits (Martin and Worthing, 1977). It has been determined that mammals store dicofol in fatty tissue. Man's recommended daily intake of dicofol should not exceed 0.025 mg/kg of body weight (Vettorazzi, 1979). Because dicofol is practically insoluble in water and unaffected by light or moisture it persists in the environment. In the soil, dicofol persists for more than one year (McEwen and Stephenson, 1979). The LC50 for the most sensitive organism reported (largemouth bass; freshwater) is 0.395 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the bluegill (freshwater) is 0.520 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). Dicofol showed positive results in tests for carcinogenicity (NIOSH, 1979).

Raw waste load concentrations of dinoseb have been monitored at levels which are declared proprietary. Dinoseb is a contact herbicide used as a post-emergence annual weed control on peas and cereals. Ammonium and amine salts are the most widely used form of dinoseb. It is an orange-brown liquid with a melting point of 30° to 40°C. Dinoseb is soluble in water at a rate of 100 mg/l (Martin and Worthing, 1977). It is highly toxic to mammals with an acute oral LD50 for rats of 58 mg/kg and an acute dermal LD50 for rabbits of 80 mg/kg to 200 mg/kg (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (lake trout; freshwater) is 0.044 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for dinoseb is 68 (Kenaga, 1979).

Raw waste load concentrations of dioxathion have been monitored at levels which are declared proprietary. Dioxathion is a nonsystemic insecticide and acaricide used on livestock for external parasites and on fruit trees and ornamentals. The technical product is a brown liquid which is insoluble in water (Martin and Worthing, 1977). Dioxathion is very toxic to mammals with an acute oral LD50 of 23 mg/kg and an acute dernal LD50 of 63 mg/kg for female rats. Ten doses of dioxathion at 0.8 mg/kg fed over 14 days reduced plasma cholinesterase activity in dogs (Martin and Worthing, 1977). No appreciable decline in dioxathion

concentration can be expected during normal storage since dioxathion residues are very stable. It has been recommended that man's daily intake of dioxathion should not exceed 0.0015 mg/kg (Vettorazzi, 1979). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.00035 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the rainbow trout (freshwater) is 0.069 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980).

Raw waste load concentrations of disulfoton have been monitored at levels which are declared proprietary. Disulfoton is a systemic insecticide and acaricide for use in protecting seeds and seedlings. It is applied as a seed or soil treatment. The technical product is a dark yellowish oil with a solubility in water of 25 mg/l at room temperature (Martin and Worthing, 1977). Disulfoton is extremely toxic to mammals with an acute oral LD50 for female rats of 2.6 mg/kg and an acute dermal LD50 of 20 mg/kg for male rats (Martin and Worthing, 1977). The primary effect of disulfoton is through inhibition of cholinesterase. In cell cultures, disulfoton inhibits protein synthesis. It has been recommended that man's daily intake should not exceed 0.002 mg/kg of body weight (Vettorazzi, 1979). When applied in the granular form, disulfoton is taken up by plants over an extended period of time. In 1971, eight million pounds were produced and about four million pounds were used by American farmers (McEwen and Stephenson, 1979). The LC50 for the most sensitive organism reported (Palaemoretes; saltwater) is 0.0039 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 0.300 mg/l and 1.850 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for disulfoton is 100 (Kenaga, 1979).

Diuron has not been monitored in raw waste loads in the pesticide industry. Diuron is a herbicide used for general weed control on crops such as sugar cane, citrus, pineapple, and cotton. Diuron kills weeds by inhibiting photosynthesis. It is a white, odorless solid with a melting point of 158° to 159°C. Its solubility in water at 25°C is 42 mg/l (Martin and Worthing, 1977). The acute oral LD50 for diuron is 3,400 mg/kg for rats. It may cause irritation to eyes and mucous membranes (Martin and Worthing, 1977). Diuron is persistent and immobile in the soil since it is stable to oxidation and moisture (McEwen and Stephenson, 1979). The LC50 for the most sensitive organism reported (G. fasciatus; saltwater) is 0.16 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 8.2 mg/l and 4.9 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for diuron is 75 (Kenaga, 1979).

Dowicil 75 has not been monitored in the pesticide industry. It is a fungicide and is freely soluble in water (Packer, 1975). The oral LD50 is 500 mg/kg for rats, and the oral LD50 for chickens is 2,000 mg/kg (NIOSH, 1977).

Ethalfluralin has not been monitored in the pesticide industry. Ethalfluralin is a pre-plant herbicide which kills germinating weeds;

however, weeds which are established are tolerant. In soil, ethalfluralin has residual action on broad-leaved and annual grass weeds in cotton, dry beans, and soybeans. The pure compound is a yellow-orange crystalline solid with a melting point of 55° to 56°C, its solubility in water is 0.2 mg/l (Martin and Worthing, 1977). The acute oral LD50 for rats is greater than 10,000 mg/kg. Skin applications of 2,000 mg/kg caused irritation to rabbits (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 0.032 mg/l and 0.193 mg/l, respectively, at 96 hours (Segna, 1981).

Raw waste load concentrations of ethion have been monitored at levels which are declared proprietary. Ethion is a nonsystemic insecticide and acaricide used on both plants and animals. Specifically, it is used on such crops as citrus, deciduous fruit, tea, and some vegetables (Vettorazzi, 1979). Ethion is a white to amber-colored liquid which is only slightly soluble in water (Martin and Worthing, 1977). Ethion is very toxic to mammals with an acute oral LD50 of 24.4 mg/kg for female rats and an acute dermal LD50 of 915 mg/kg for rabbits. Female rats on a 28-day feeding program showed evidence of cholinesterase inhibition at the 10 ppm level. Ethion is phytotoxic to some apple varieties (Martin and Worthing, 1977). Ethion residues were present in the milk and fatty tissues of dairy cattle after feeding ethion at a level which simulates contaminated fodder. It has been recommended that man's daily intake of ethion should not exceed 0.05 mg/kg (Vettorazzi, 1979). Ethion is persistent in the soil for several months (McEwen and Stephenson, 1979). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.000056 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 0.210 mg/l and 0.500 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for ethion is 418 (Kenaga, 1979).

Raw waste load concentrations of ethoprop have been monitored at levels which are declared proprietary. Ethoprop is a nonsystemic, nonfumigant nematicide and soil insecticide used on many crops. It is a clear, pale yellow liquid with a boiling point of 86° to 91°C. Ethoprop is soluble in water at a rate of 750 mg/l (Martin and Worthing, 1977). Ethoprop is highly toxic to mammals with an acute oral LD50 of 62 mg/kg for albino rats and an acute dermal LD50 of 26 mg/kg for albino rabbits. In a study of dogs and rats, there was evidence of depression of cholinesterase levels (Martin and Worthing, 1977). The LC50 for the rainbow trout (freshwater) is 1.15 mg/l at 96 hours (Piecuch, 1980).

Etridiazole has not been monitored in the pesticide industry. Etridiazole is a fungicide used for control of some soil-borne diseases of turf and ornamentals. It is also used as a seed treatment for pre- and post-emergence cotton seedling diseases. The technical product is a reddish-brown liquid which is practically insoluble in water. The acute oral LD50 for mice is 2,000 mg/kg (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (Daphnia; saltwater) is 4.9 mg/l at 96 hours (Segna, 1981). The LC50s for the bluegill and

rainbow trout (freshwater) are 9.0 mg/l and 2.52 mg/l, respectively, at 96 hours (Segna, 1981).

Raw waste load concentrations of fensulfothion have been monitored at levels which are declared proprietary. Fensulfothion is an insecticide and nematicide applied to soil and has long persistence and some systemic activity. Fensulfothion can penetrate plant tissue. It is an oily yellow liquid with a boiling point of 138° to 141°C. Fensulfothion is only slightly soluble in water with a rate of 1.5 g/l at 25°C (Martin and Worthing, 1977). Fensulfothion is extremely toxic to mammals. In both plants and animals it is metabolized by oxidation to more toxic substances (Vettorazzi, 1979). The acute oral LD50 for male rats is 4.7 mg/kg to 10.5 mg/kg and the acute dermal LD50 for female rats is 3.5 mg/kg (Martin and Worthing, 1977). It has been recommended that man's daily intake of fensulfothion should not exceed 0.003 mg/kg. Fensulfothion persists in the soil for months. In 1971, four million pounds were produced in the United States (McEwen and Stephenson, 1979). The LC50 for the most sensitive species reported (G. fasciatus; saltwater) is 0.01 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 0.107 mg/l and 9.06 mg/l, respectively, at 96 hours (Segna, 1981).

Raw waste load concentrations of fenthion have been monitored at levels which are declared proprietary. Fenthion is a contact and stomach insecticide with penetrating action used against fruit flies, leaf hoppers, and cereal bugs. The technical product is a brown, oily liquid with a weak garlic odor. Fenthion is soluble in water at room temperature at a rate of 54 mg/l to 56 mg/l (Martin and Worthing, 1977). The acute oral LD50 is 190 mg/kg to 315 mg/kg for male rats. The acute dermal LD50 is 330 mg/kg to 500 mg/kg for rats. Fenthion is of greater toxicity to dogs and poultry than to rats. The first metabolites of fenthion sulphoxide and sulphone, are readily formed in plants by oxidation and are more toxic to mammals than the pesticide product. The acute oral LD50 is 125 mg/kg for rats (Martin and Worthing, 1977). Cholinesterase inhibition was suggested as the most sensitive biological effect from short term studies on rats and dogs. The same tests indicated that the animals did not respond to any known antidotes. In both the rats and the dogs, the spleen was affected. It has been recommended that man's daily intake of fenthion should not exceed 0.005 mg/kg (Vettorazzi, 1979). Fenthion persists in the soil for several months (Vettorazzi, 1979). The EC50 for the most sensitive organism reported (Simocephalus; saltwater) is 0.00062 mg/l at 48 hours (U.S. Fish and Wildlife Services, 1980).

Fenuron has not been monitored in the pesticide industry. Fenuron is a herbicide which is absorbed through roots and acts by inhibiting photosynthesis. It is used especially on woody plants. Fenuron is a white, odorless crystalline solid with a melting point of 133° to 134°C. Its solubility in water is 3.85° g/l at 25°C. The acute oral LD50 of fenuron is 6,400 mg/kg for rats (Martin and Worthing, 1977). The predicted BCF value for fenuron is 6 (Kenaga, 1979).

Fenuron-TCA has not been monitored in the pesticide industry. Fenuron-TCA is a mixture of the two herbicides, fenuron and TCA. It is recommended for the control of woody plants on noncrop areas. Fenuron-TCA is a white, odorless crystalline solid with a melting point of 65° to 68°C. Its solubility in water is 4.8 g/l at room temperature. The acute oral LD50 for female albino rats is 4,000 mg/kg (Martin and Worthing, 1977).

Ferbam has not been monitored in the pesticide industry. Ferbam is a fungicide used mainly for the protection of foliage by spraying. It is a black powder with a solubility in water of 130 mg/l at room temperature (Martin and Worthing, 1977). The acute oral LD50 for rats is more than 17 g/kg (Martin and Worthing, 1977). It has been shown that ferbam increases the skeletal stores of iron in the rat. Ferbam can react with nitrite under mildly acid conditions, like those in the human stomach, to produce N-nitrosodimethylamine which has been shown to be carcinogenic in several animal species (Vettorazzi, 1979). It has been recommended that man's daily intake of ferbam should not exceed 0.02 mg/kg (Vettorazzi, 1979).

Raw waste load concentrations of fluometuron have been monitored at levels which are declared proprietary. Fluometuron is a herbicide with weak foliar activity which can be absorbed through roots. It is used for control of broad-leaved and grass weeds. Fluometuron is in the form of white crystals with a melting point of 163° to 164.5°C. Its solubility in water at 20°C is 105 mg/l (Martin and Worthing, 1977). The acute oral LD50 is greater than 8,000 mg/kg for rats (Martin and Worthing, 1977). The LC50 for the rainbow trout (freshwater) is 3.0 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for fluometuron is 47 (Kenaga, 1979).

Fluoroacetimide has not been monitored in the pesticide industry. It is used as a rodenticide and insecticide. The oral LD50 for rats is 15 mg/kg (Windholz, 1976). It is very soluble in water. The skin LD50 is 80 mg/kg for rats. The intravenous LD50 is 0.250 mg/kg for rabbits (NIOSH, 1977).

Glyodin has not been monitored in the pesticide industry. Glyodin is used as a fungicide. Its melting point is from 62 to 68°C (Windholz, 1976). The oral LDlo is 50 mg/kg for humans. The oral LD50 for rats is 6.80 mg/kg (NIOSH, 1977). The LC50 for the rainbow trout (freshwater) is 0.47 mg/l at 96 hours (Segna, 1981).

Raw waste load concentrations of glyphosate have been monitored at levels which are declared proprietary. Glyphosate is a relatively nonselective, post-emergent herbicide used on annual and perennial grasses, sedges, and broad-leaved weeds. It is a white solid that melts with decomposition at 230°C. Its solubility in water is 12 g/l at 25°C (Martin and Worthing, 1977). The acute dermal LD50 is 4,320 mg/kg for rabbits and the acute dermal LD50 for rabbits is greater than 8 g/kg (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (fathead minnow; freshwater) is 1.0 mg/l to 2.3 mg/l at

96 hours (Piecuch, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 135 mg/l and 130 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for glyphosate is 3 (Kenaga, 1979).

Raw waste load concentrations of hexazinone have been monitored at levels which are declared proprietary. Hexazinone is a post-emergence contact herbicide used against many annual, biennial, and perennial weeds. It is a white, odorless, crystalline solid with a melting point of 115° to 117°C. Hexazinone is soluble in water at a rate of 33 g/kg at 25°C (Martin and Worthing, 1977). The TLM (96-hour) for bluegill sunfish is between 370 mg/l and 420 mg/l. The acute oral LD50 is 860 mg/kg for guinea pigs and the acute dermal LD50 is more than 5,278 mg/kg. Small doses in rabbit eyes causes irritation and hexazinone has been classified as an eye irritant (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (Daphnia; saltwater) is 145.3 mg/l at 96 hours (Segna, 1981). The LC50s for the bluegill and rainbow trout (freshwater) are greater than 370 mg/l to less than 420 mg/l and greater than 320 mg/l to less than 420 mg/l, respectively, at 96 hours (Segna, 1981).

HPTMS has not been monitored in the pesticide industry. It is a fungicide used for seed treatment and slime control (Packer, 1975). The oral LD50 for rats is 794 mg/kg (NIOSH, 1977).

Isopropalin has not been monitored in the pesticide industry. Isopropalin is a pre-plant herbicide incorporated in the soil for direct seeded tomatoes. It is a red-orange liquid with a solubility in water of 0.1 mg/l. The acute oral LD50 for mice and rats is greater than 5,000 mg/kg. Isopropalin causes skin irritation in rabbits (Martin and Worthing, 1977). The predicted BCF value for isopropalin is 7,500 (Kenaga, 1979).

KN methyl has not been monitored in the pesticide industry. KN methyl is a fungicide. The oral TDlo is 129 gm/kg for mice (NIOSH, 1979). Animal studies have revealed carcinogenic properties for this product (NIOSH, 1977).

Raw waste load concentrations of linuron have been monitored at declared proprietary levels. Linuron is a selective pre- and post-emergence herbicide which inhibits photosynthesis. It is used on soybeans, cotton, potatoes, carrots, and winter wheat. Linuron is a white odorless crystalline solid with a melting point of 93° to 94°C. Its solubility in water is 75 mg/l at 25°C (Martin and Worthing, 1977) and the acute oral LD50 of linuron is 500 mg/kg for dogs. Linuron causes irritation to the skin of guinea pigs (Martin and Worthing, 1977). Linuron decomposes slowly in soil, persisting up to 4 months (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 2.8 mg/l and 1.8 mg/l, respectively, at 96 hours (Segna, 1981). The predicted BCF value for linuron is 54 (Kenaga, 1979).

Raw waste load concentrations of malathion have been monitored at levels which are declared proprietary. Malathion is a nonsystemic insecticide and acaricide. It can be phytotoxic to cucumber, string bean, and squash. Malathion has a wide range of uses including agricultural, horticultural, and household pest. It is a clear, amber liquid with a boiling point of 156° to 157°C. Its solubility in water is 145 mg/l at room temperature (Martin and Worthing, 1977). The acute oral LD50 for rats is 2,800 mg/kg and the acute dermal LD50 is 4,100 mg/kg for rabbits. Malathion is highly toxic to honey bees (Martin and Worthing, 1977). It has been recommended that man's daily intake of malathion should not exceed 0.02 mg/kg (Vettorazzi, 1979). In 1971, the United States produced 3.5 million pounds of malathion (McEwen and Stephenson, 1979). The LC50 for the most sensitive organism reported (Isoperta; saltwater) is 0.00069 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 0.103 mg/l and 0.200 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF values for malathion is 37 (Kenaga, 1979).

Mancozeb has not been monitored in the pesticide industry. Mancozeb is a protective fungicide used against a wide range of foliage diseases. It is a greyish-yellow powder and is practically insoluble in water (Martin and Worthing, 1977). The acute oral LD50 for rats is more than 8,000 mg/kg. Mancozeb causes skin irritation on repeated exposure (Martin and Worthing, 1977). Concentrations of ethylenethiourea (ETU) have been found in mancozeb. ETU produced thyroid and liver tumors in experimental animals. In addition, ETU is teratogenic and mutagenic. In a three generation study with rats, reduced fertility was noted (Vettorazzi, 1979). It has been recommended that man's daily intake of mancozeb should not exceed 0.005 mg/kg of body weight (Vettorazzi, 1979). The LC50 for the rainbow trout (freshwater) is 0.64 mg/l at 96 hours (EPA, OPP).

Maneb has not been monitored in the pesticide industry. Maneb is a protective fungicide used against many foliage diseases in potatoes and tomatoes. It is a yellow crystalline solid which is only slightly soluble in water (Martin and Worthing, 1977). The acute oral LD50 and inhalation LD50 for rats are 6,750 mg/kg (Martin and Worthing, 1977) and 3,000 mg/kg (Little, 1980), respectively. Toxicity to fish in the 96-hour TLM is 0.1 mg/l to 1.0 mg/l (Little, 1980). The chemical breakdown of maneb produces ethylenethiourea (ETU). ETU has been found to produce thyroid and liver tumors and is also teratogenic and mutagenic (Vettorazzi, 1979). It has been recommended that man's daily intake of maneb should not exceed 0.005 mg/kg of body weight (Vettorazzi, 1979). This is equal to 0.36 mg per day for a 160 pound human. The LC50 for the bluegill (freshwater) is 1.0 mg/l at 96 hours (EPA, OPP).

Raw waste load concentrations of mephosfolan have been monitored at levels which are declared proprietary. Mephosfolan is a contact and stomach insecticide which demonstrates systemic activity following root or foliar absorption. It is used on such crops as cotton, vegetables,

fruit, and field crops. It is a yellow to amber liquid with a boiling point of 120°C. Mephosfolan is moderately soluble in water (Martin and Worthing, 1977). Mephosfolan is extremely toxic to mammals with an acute oral LD50 for rats of 8.9 mg/kg of body weight and an acute dermal LD50 of 9.7 mg/kg for male albino rabbits. In 90-day feeding tests, male rats fed at rates up to 15 ppm demonstrated a reduction in erythrocyte and brain cholinesterase activity (Martin and Worthing, 1977).

Merphos has not been monitored in the pesticide industry. Merphos is used to defoliate cotton prior to harvest. It is a colorless to pale yellow liquid with a boiling point of 115° to 134°C. Merphos has a very low solubility in water. The acute oral LD50 for male albino rats is 1,272 mg/kg and the acute dermal LD50 is greater than 4,600 mg/kg for albino rabbits. Dogs and cats fed for 90 days with a diet containing 750 ppm showed depression of cholinesterase levels (Martin and Worthing, 1977). The LC50 for the rainbow trout (freshwater) is 33 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980).

Metasol J-26 has not been monitored in the pesticide industry and no information on toxicity was available at time of publication.

Metham has not been monitored in raw waste loads in the pesticide industry. Metham is a soil fungicide, nematicide, and herbicide which has fumigant action. It decomposes to the active component methyl isothiocyanate. Metham is phytotoxic and is persistent in soil for approximately two weeks. It is a white, crystalline solid with a solubility in water of 722 g/l at 20°C (Martin and Worthing, 1977). The acute oral LD50 of metham is 285 mg/kg for albino mice and the acute oral LD50 of methyl isothiocyanate is 97 mg/kg. The acute dermal LD50 is 800 mg/kg for rabbits. Metham is an irritant to the eyes, skin, and mucous membranes. Exposure to the skin or eyes should be treated as a burn (Martin and Worthing, 1977).

Methiocarb has not been monitored in the pesticide industry. Methiocarb is a nonsystemic insecticide and acaricide with a broad range of action which includes effectiveness in killing snails. It is also used as a bird repellent by seed dressing. Methiocarb is a white crystalline powder with a melting point of 117° to 118°C. It is practically insoluble in water. The acute oral LD50 is 100 mg/kg for male rats and 40 mg/kg for guinea-pigs and the acute dermal LD50 is 350 mg/kg to 400 mg/kg for male rats (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (Pteronarcys; saltwater) is 0.005 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the bluegill and rainbow trout (freshwater) is 0.21 mg/l and 0.80 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Raw waste load concentrations of methomyl have been monitored at levels which are declared proprietary. Methomyl is used for control of many insects by foliar application and has systemic action when incorporated in the soil. It is a white crystalline solid with a slight sulphurous odor. The melting point is 78 to 79°C. Methomyl is soluble in water at

a rate of 58 g/l at 25°C (Martin and Worthing, 1977). The TLM (96-hour) is 3.4 mg/l for rainbow trout and 0.1 mg/l for goldfish. The acute oral LD50 of 24 percent methomyl liquid is 17 to 214 mg/kg for rats. The acute dermal LD50 is greater than 5,000 mg/kg for rabbits for the 24 percent liquid (Martin and Worthing, 1977). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.0088 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 1.050 mg/l and 1.600 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for methomyl is 3 (Kenaga, 1979).

Methoxychlor has not been monitored in raw waste loads in the pesticide industry. Methoxychlor is a nonsystemic contact and stomach insecticide. It has been recommended for fly control in dairy barns, and is used on many crops near harvest time (McEwen and Stephenson, 1979). Methoxychlor is a grey, flaky powder which is practically insoluble in water (Martin and Worthing, 1977). The acute oral LD50 is 6,000 mg/kg for rats (Martin and Worthing, 1977). Methoxychlor is highly toxic to fish. It has been recommended that man's daily intake of methoxychlor should not exceed 0.1 mg/kg (Vettorazzi, 1979). The LC50 for the most sensitive organism reported (Oronectes; saltwater) is 0.00050 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 0.032 mg/l and 0.062 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The calculated BCF value for methoxychlor is 185 (Kenaga, 1979).

Raw waste load concentrations of metribuzin have been monitored at levels which are declared proprietary. Metribuzin is a herbicide used in soybeans, potatoes, tomatoes, and other crops. The technical product is white to yellowish and crystalline, and its solubility in water is 1.2 g/l at 20°C (Martin and Worthing, 1977). The acute oral LD50 is 698 mg/kg for male mice. The LC50s for the bluegill and rainbow trout (freshwater) are 80.0 mg/l and 76 mg/l to 147 mg/l, respectively, at 96 hours (Segna, 1981). The predicted BCF value for metribuzin is 11 (Kenaga, 1979).

Mevinphos has not been monitored in the pesticide industry. Mevinphos is a volatile contact and systemic insecticide and acaricide used against sap-feeding insects, mites, beetles, and caterpillars. The technical product is a pale yellow to orange liquid with a mild odor. The boiling point is 99° to 103°C. Mevinphos is miscible in water (Martin and Worthing, 1977). Mevinphos is extremely toxic to fish and mammals. The TLM (24-hour) for mosquito fish is 0.8 mg/l. The acute oral LD50 is 3 mg/kg to 12 mg/kg for rats, and the acute dermal LD50 is 16 mg/kg to 34 mg/kg for rabbits (Martin and Worthing, 1977). It has been recommended that man's daily intake of mevinphos should not exceed 0.0015 mg/kg (Vettorazzi, 1979). Reproduction studies of mammals showed a reduction in milk production at the 1.2 mg/kg/day level (Vettorazzi, 1979). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.00018 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are

0.0225 mg/l and 0.0119 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Mexacarbate has not been monitored in the pesticide industry. It is used as a molluscicide and has a very low solubility of 0.01 percent at 25°C. Its melting point is 85°C (Windholz, 1976). The oral LD50 for female rats is 25 mg/kg (Windholz, 1976). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.010 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 22.9 mg/l and 12.0 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for mexacarbate is 42 (Kenaga, 1979).

Mirex has not been monitored in the pesticide industry. Mirex is a stomach insecticide with little contact activity. Its widest use has been against fire ants. Mirex is a white solid which is practically insoluble in water (Martin and Worthing, 1977). Mirex is toxic to birds, fish, and crustaceans. The acute oral LD50 is 306 mg/kg for male albino rats. The acute dermal LD50 is 800 mg/kg for rabbits (Martin and Worthing, 1977). Mirex has been shown to produce an increased incidence of hepatomas in both sexes of two strains of mice (Vettorazzi, 1979). A large number of workers contracted a severe, debilitating disease at a plant which manufactured a closely related metabolite of mirex called chlordecone. The EC50 for the most sensitive organism reported (Simocephalus; saltwater) is greater than 0.100 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the rainbow trout (freshwater) is greater than 100 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for mirex is 820 (Kenaga, 1979).

Monuron has not been monitored in the pesticide industry. Monuron is a herbicide which is absorbed by roots and is an inhibitor of photosynthesis. It is used on noncrop land such as rights-of-way, industrial sites, and drainage ditches. Monuron is a white odorless crystalline solid with a melting point of 174° to 175°C. Its solubility in water is 230 mg/l at 25°C. The mammalian toxicity of monuron is moderate (LD50 for rats 3,600 mg/kg); however, it is a suspected carcinogen. In studies of mice which were fed monuron orally, an increased incidence of liver and lung tumors was observed. Tumors were observed at various sites in rats which were fed monuron (Vettorazzi, 1979). The LC50 for the bluegill (freshwater) is 3.6 mg/l at 96 hours (Piecuch, 1980). The predicted BCF value for monuron is 29 (Kenaga, 1979).

Monuron-TCA has not been monitored in the pesticide industry. Monuron-TCA is a general herbicide used for total weed control in uncropped areas such as rights-of-way, industrial sites, and drainage ditches. Monuron-TCA is a crystalline solid with a melting point of 78° to 81°C. Its solubility in water is 918 mg/l at room temperature. The acute oral LD50 of monuron-TCA in corn oil for female rats is 2,300 mg/kg. Monuron-TCA is a skin irritant and harmful to mucous membranes (Martin and Worthing, 1977).

Nabam has not been monitored in the pesticide industry. Nabam is a protective fungicide which, when applied to the soil, has systemic action. Nabam is too phytotoxic to be applied to foliage. It exists in the form of colorless crystals. Nabam is 20 percent soluble in water at room temperature and forms a yellow solution (Martin and Worthing, 1977). The acute LD50 is 395 mg/kg for rats (Martin and Worthing, 1977). The LC50 for the harlequin fish (saltwater) is 0.7 mg/l at 96 hours (Piecuch, 1981).

Naled has not been monitored in the pesticide industry. Naled is a fast-acting nonsystemic contact and stomach insecticide and acaricide with fumigant action. It is recommended for use in greenhouses, mushroom houses, and against adult mosquitoes and flies on crops. Naled is a yellow liquid with a slightly pungent odor and a boiling point of 110°C. It is practically insoluble in water (Martin and Worthing, 1977). The TLM (24-hour) is 2 mg/l to 4 mg/l for goldfish and 0.33 mg/l for crabs. The acute oral LD50 is 430 mg/kg for rats, and the acute dermal LD50 is 1,100 mg/kg for rabbits (Martin and Worthing, 1977). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.0004 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 2.200 mg/l and 0.195 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Neburon has not been monitored in the pesticide industry. Neburon is a pre-emergence herbicide which is absorbed through roots and acts by inhibiting photosynthesis. It is recommended for control of annual weeds and grasses in wheat, strawberries, and nursery plantings of certain woody ornamentals. Neburon is a white, odorless, crystalline solid with a melting point of 102°C to 103°C. Its solubility in water is 4.8 mg/kg at 24°C. The acute oral LD50 of neburon is greater than 11,000 mg/kg for rats. The predicted BCF value for neburon is 255 (Kenaga, 1979).

Niacide has not been monitored in the pesticide industry. Niacide is a fungicide. The oral LD50 for humans is 500 mg/kg. The intraperitoneal LD50 is 2,700 kg/mg for rats. The oral LD50 is 4,000 mg/kg for rats (NIOSH, 1977). The LC50 for the bluegill (freshwater) is 1.8 mg/l at 96 hours (Piecuch, 1980).

Oxamyl has not been monitored in the pesticide industry. Oxamyl is a contact-type insecticide with residual action. It is applied to foliage and soil. In plants, oxamyl translocates in both an upward and downward direction. Oxamyl is applied to soil to control nematodes and to foliage to control a variety of insects. Oxamyl is a white, crystalline solid with a slight sulphurous odor. Its melting point is 100°C to 102°C and is soluble in water at a rate of 280 g/kg at 25°C (Martin and Worthing, 1977). Oxamyl is extremely toxic to fish and mammals. The TLM (96-hour) is 5.6 mg/l for bluegill, sunfish, and goldfish and 4.2 mg/l for rainbow trout. The acute oral LD50 is 5.4 mg/kg for male rats, and the acute dermal LD50 for male rabbits is 2,960 mg/kg (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported

(Daphnia, saltwater) is 0.49 mg/l at 96 hours (Segna, 1981). The LC50s for the bluegill and rainbow trout (freshwater) are 5.6 mg/l and 4.2 mg/l, respectively, at 96 hours (Segna, 1981).

Parathion ethyl has been detected in raw waste loads at declared proprietary concentrations. The LC50 for the most sensitive organism reported (Orconectes, saltwater) is 0.00004 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 0.024 mg/l and 0.750 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Raw waste load concentrations of parathion methyl have been monitored at levels which are declared proprietary. Parathion methyl is a non-systemic contact and stomach insecticide which has some fumigant action. Parathion methyl is used as a household spray for ants and cockroaches (McEwen and Stephenson, 1979). It is a white-crystalline powder with a melting point of 35° to 36°C. Approximately 60 mg/l is soluble in water at 25°C. The technical product is a light to dark tan liquid (Martin and Worthing, 1977). Parathion methyl is highly toxic to wildlife. Reproduction studies show disturbance of the physiology of reproduction (Vettorazzi, 1979). The acute oral LD50 for male rats is 14 mg/kg, and the acute dermal LD50 for rats is 67 mg/kg (Martin and Worthing, 1977). It has been recommended that man's daily intake of parathion methyl should not exceed 0.001 mg/kg of body weight. In 1971, 10 million pounds of parathion methyl were produced, of which three million pounds were used in agriculture. The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.00014 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 4.380 mg/l and 3.700 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Raw waste load concentrations of PCNB have been monitored at levels which are declared proprietary. PCNB is a fungicide used for seed and soil treatment. It exists in the form of colorless needles with a melting point of 146°C. PCNB is practically insoluble in water (Martin and Worthing, 1977). An increased number of eye abnormalities, cleft palates, and renal agenesia were observed in mice after exposure to PCNB. In a 2-year study using dogs, morphological changes occurred in the liver and bone marrow (Vettorazzi, 1979). The acute oral LD50 for rats is greater than 12,000 mg/kg (Martin and Worthing, 1977). It has been recommended that man's daily intake of PCNB should not exceed 0.007 mg/kg (Vettorazzi, 1979). The LC50s for the bluegill and rainbow trout (freshwater) are 1.40 mg/l and 0.047 mg/l, respectively, at 96 hours (Segna, 1981). PCNB showed positive results in testing for carcinogenicity (Residue Reviews, 1975).

PCP salt has not been monitored in the pesticide industry. PCP salt exists in the form of buff flakes with a solubility in water of 330 g/kg at 25°C (Martin and Worthing, 1977). The acute oral LD50 for rats is 210 mg/kg (NIOSH, 1979). The LC50 for the bluegill and rainbow trout (freshwater) is 0.044 mg/l and 0.055 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Perthane has not been monitored in the pesticide industry. Perthane is a nonsystemic insecticide with specific applications. It is recommended for use against pear psylla, leaf hoppers, and various larvae on vegetable crops. Perthane is also used to control clothes moths and carpet beetles. The technical product is a wax with a melting point above 40°C and is practically insoluble in water. The acute oral LD50 is 6,600 mg/kg for mice. Perthane is of moderate persistence in soil. The LC50 for the bluegill and rainbow trout (freshwater) is 0.020 mg/l and 0.004 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980).

Raw waste load concentrations of phorate have been monitored at levels which are declared proprietary. Phorate is a systemic and contact insecticide and acaricide used to protect crops such as root and field crops, cotton, and coffee. It is also used as a soil insecticide on corn and sugar beets. Phorate is a clear liquid with a boiling point of 118° to 120°C. Its solubility in water is 50 mg/l at room temperature (Martin and Worthing, 1977). The major metabolites of phorate in both plants and animals are sulfoxides, sulfones, and phoratoxon which demonstrate high cholinesterase activity (Vettorazzi, 1979). Phorate is extremely toxic to mammals. The acute oral LD50 is 1.6 mg/kg, and the acute dermal LD50 is 2.5 mg/kg for female rats (Martin and Worthing, 1977). Phorate is very persistent in the environment. It has been shown that carrots are capable of taking up and storing large quantities of phorate (Vettorazzi, 1979). The LC50 for the most sensitive organism reported (bluegill; freshwater) is 0.0018 mg/l at 96 hours (Segna, 1981). The LC50 for the rainbow trout (freshwater) is 0.013 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for phorate is 68 (Kenaga, 1979).

Raw waste load concentrations of profluralin have been monitored at declared proprietary levels. Profluralin is a preplant herbicide applied to soil. It is used to control annual and perennial weeds and grasses in cotton, soybeans, and other crops. It is a yellow- orange crystalline solid with a melting point of 32°C. At 20°C, 0.1 mg of profluralin will dissolve in 1 liter of water. The acute oral LD50 is 10,000 mg/kg for rats, and the acute dermal LD50 for rats is greater than 3,170 mg/kg (Martin and Worthing, 1977). The predicted BCF value for profluralin is 2,260 (Kenaga, 1979).

Raw waste load concentrations of prometon have been monitored at declared proprietary levels. Prometon is a nonselective herbicide for the control of annual and perennial broad-leaved and grass weeds. The inclusion of prometon in asphalt is under investigation. Prometon is a white crystalline solid with a melting point of 91° to 92°C. Its solubility in water is 750 mg/l at 20°C. The acute oral LD50 is 2,980 mg/kg for rats, and the acute dermal LD50 is 2,200 mg/kg for rabbits (Martin and Worthing, 1977). The LC50 for the bluegill and rainbow trout (freshwater) is greater than 32.0 mg/l and 20 mg/l, respectively, at 96 hours (Segna, 1981). The predicted BCF value for prometon is 15 (Kenaga, 1979).

Raw waste load concentrations of prometryn have been monitored at declared proprietary levels. Prometryn is a pre- and post-emergence herbicide which is used for selective weed control in cotton, peas, carrots, celery, and potatoes. It is a white crystalline solid with a melting point of 118° to 120°C. Prometryn is soluble in water at a rate of 48 mg/l at 20°C. The acute oral LD50 for rats is 3,150 to 3,750 mg/kg, and the acute dermal LD50 is greater than 10,200 mg/kg for rabbits. Prometryn persists in the soil from 1 month to 3 months (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 10 mg/l and 2.5 mg/l, respectively, at 96 hours (Segna, 1981). The predicted BCF value for prometryn is 70 (Kenaga, 1979).

Raw waste load concentrations of propachlor have been monitored at levels which are declared proprietary. Propachlor is a pre-emergence herbicide used against annual grasses and certain broad-leaved weeds in corn, cotton, soybeans, and several other vegetable crops. It is a light tan solid with a melting point of 67° to 76°C. Propachlor is soluble in water at a rate of 700 mg/l at 20°C. The acute oral LD50 of a 65 percent working product is 1,200 mg/kg for rats. The acute dermal LD50 of a 10.4 percent suspension in water is 380 mg/kg for rabbits. Propachlor persists in the soil from 4 to 6 weeks (Martin and Worthing, 1977). The LC50 for the bluegill (freshwater) is 3.6 mg/l at 96 hours (EPA, OPP). The predicted BCF value for propachlor is 17 (Kenaga, 1979).

Raw waste load concentrations of propazine have been monitored at levels which are declared proprietary. Propazine is a pre-emergence herbicide used against broad-leaved and grass weeds in millet and carrots. It is in the form of colorless crystals with a melting point of 212° to 214°C. Propazine is soluble in water at a rate of 8.6 mg/l at 20°C. It is toxic to quail, ducks, trout, bluegills, and mammals. The acute oral LD50 is greater than 5,000 mg/kg for rats, and the acute dermal LD50 is greater than 10,200 mg/kg for rabbits (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are greater than 100 mg/l and 17.5 mg/l, respectively, at 96 hours (Segna, 1981). The predicted BCF value for propazine is 184 (Kenaga, 1979).

Propham has not been monitored in the pesticide industry. Propham is a selective pre-planting, pre-emergence, and post-emergence herbicide used mainly for the control of annual grass weeds in peas and beets. It is absorbed by roots and acts by inhibiting cell mitosis (Vettorazzi, 1979). It exists in the form of white crystals with a melting point of 87° to 87.6°C. Prophams' solubility in water has been reported at various rates including 32 mg/l, 100 mg/l, and 250 mg/l from 20° to 25°C (Martin and Worthing, 1977). The acute oral LD50 is 5,000 mg/kg for rats. It has been shown that propham had a tumor-initiating activity when applied to the skin of rats and acts as an initiator in 2-stage carcinogenesis when administered orally to mice (Vettorazzi, 1979). The EC50 for the most sensitive organism (Daphnia; saltwater) is 8.0 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 29 mg/l and 38 mg/l,

respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for propham is 27 (Kenaga, 1979).

Propoxur has not been monitored in the pesticide industry. Propoxur is a nonsystemic insecticide with rapid knock-down power. It is used extensively on field crops, fruits, and vegetables, and in the household against flies and cockroaches. Propoxur has some systemic action in plants. It is a white crystalline powder with a faint odor and a melting point of 84° to 87°C. Propoxur is soluble in water at a rate of 2 g/l at 20°C (Martin and Worthing, 1977). The acute oral LD50 is 90 to 128 mg/kg for male rats and 40 mg/kg for guinea pigs. Propoxur is highly toxic to birds. The acute oral LD50 for red-winged blackbirds is 2 mg/kg to 6 mg/kg and 15 mg/kg to 20 mg/kg for starlings. It is extremely toxic to honey bees (Martin and Worthing, 1977). Propoxur has residual activity for several weeks when applied indoors (McEwen and Stephenson, 1979). The LC50 for the most sensitive organism reported (Pteronarcys; saltwater) is 0.018 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 4.800 mg/l and 8.200 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for propoxur is 9 (Kenaga, 1979).

Pyrethrin has not been monitored in the pesticide industry. Pyrethrins are potent, nonsystemic, contact insecticides causing rapid paralysis. Pyrethrins are practically insoluble in water. They break down in the presence of sunlight and are rapidly oxidized in air. The acute oral LD50 is 584 mg/kg to 900 mg/kg, and the acute dermal LD50 is greater than 1,500 mg/kg for rats (Martin and Worthing, 1977). It has been recommended that man's daily intake of pyrethrins should not exceed 0.04 mg/kg (Vettorazzi, 1979). The LC50s for the bluegill and rainbow trout (freshwater) are 0.049 mg/l and 0.054 mg/l, respectively, at 96 hours (Segna, 1981).

Ronnel has not been monitored in the pesticide industry. Ronnel is a systemic insecticide which is used as a residual spray for flies and other household pests. It is also used as a spray for control of ectoparasites of livestock, poultry, and household pets. Ronnel is a white, crystalline powder with a melting point of 40° to 42°C. Its solubility in water is 40 mg/l (Martin and Worthing, 1977). Ronnel is phytotoxic to plants. Its most sensitive effect on animals is the inhibition of cholinesterase activity. It has been recommended that man's daily intake of ronnel should not exceed 0.01 mg/kg (Vettorazzi, 1979). The acute oral LD50 for rats is 1,740 mg/kg, and the acute dermal LD50 is 2,000 mg/kg (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (rainbow trout; freshwater) is 0.550 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the bluegill (freshwater) is 1.300 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for ronnel is 225 (Kenaga, 1979).

Siduron has not been monitored in the pesticide industry. Siduron is a selective herbicide which is used to control crabgrass and annual weed

grasses. It is a white, odorless, crystalline, solid with a melting point of 133° to 138°C. Siduron is soluble in water at a rate of 18 mg/l at 25°C. The acute oral LD50 for rats is more than 7,500 mg/kg (Martin and Worthing, 1977). The LC50 for rainbow trout (freshwater) is 9.4 mg/l at 96 hours (EPA, OPP).

Raw waste load concentrations of silvex have been monitored at levels which are declared proprietary. Silvex is a hormone-type herbicide which is absorbed by leaves and stems and demonstrates translocation properties. It is used for control of brush submergent and emergent aquatic weeds, and weed control for certain crops. Silvex is a white powder which is soluble in water at a rate of 140 mg/l at 25°C. The acute oral LD50 is 650 mg/kg for rats. Silvex is painful to the eyes (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 103 mg/l and 70.0 mg/l, respectively, at 96 hours (Segna, 1981). The predicted BCF value for silvex is 38 (Kenaga, 1979).

Silvex isooctyl ester has not been monitored in the pesticide industry. See silvex for environmental and health effects. The LC50 for the rainbow trout (freshwater) is 22.0 mg/l at 96 hours (EPA, OPP).

Silvex salt has not been monitored in the pesticide industry. See silvex for environmental and health effects.

Raw waste load concentrations of simazine have been monitored at levels which are declared proprietary. Simazine is a pre-emergence herbicide used for the control of broad-leaved and grassy weeds in deep-rooted crops such as citrus, deciduous fruits, and olives. It is a white crystalline solid with a melting point of 225° to 227°C. Simazine is soluble in water at a rate of 5 mg/l at 20° to 22°C. The acute oral LD50 for rats is greater than 5,000 mg/kg, and the acute dermal LD50 is greater than 10,200 mg/kg for rabbits (Martin and Worthing, 1977). The EC50 for the most sensitive organism reported (Daphnia; saltwater) is 1.1 mg/l at 48 hours (U.S. Fish and Wildlife Service, 1980). The LC50s for the bluegill and rainbow trout (freshwater) are 16 mg/l and 5.2 mg/l, respectively, at 96 hours (Segna, 1981). The calculated BCF value for simazine is 1 (Kenaga, 1979).

Raw waste load concentrations of simetryne have been monitored at declared proprietary levels. Simetryne is a herbicide which is used in combination with S-4-chlorobenzyl diethyldithiocarbamate to control woodleafed weeds in rice. It is in the form of white crystals with a melting point of 82° to 83°C. Simetryne is soluble in water at a rate of 450 mg/l at room temperature. The acute oral LD50 is 1,830 mg/kg for rats (Martin and Worthing, 1977).

Sodium monofluoroacetate has not been monitored in the pesticide industry. Sodium monofluoroacetate is an extremely strong mammalian poison. It is a white, hydroscopic powder which is very water soluble (Martin and Worthing, 1977). Sodium monofluoroacetate is a strong inhibitor of respiration at the cellular level (McEwen and Stephenson,

1979). The acute oral LD50 is 0.22 mg/kg for the Norway rat (Martin and Worthing, 1977).

Stirofos has not been monitored in the pesticide industry. Stirofos is a selective insecticide used to kill insects on fruit, rice, cotton, corn, and other vegetables. The technical product is a white crystalline solid with a solubility in water of 11 mg/l at 20°C. The acute oral LD50 is 2,500 mg/kg for rats and 5,000 mg/kg for mice. The acute dermal LD50 is greater than 2,500 mg/kg for rabbits. The acute oral LD50 for mallard ducks is greater than 2,000 mg/kg (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 0.05 mg/l and 0.38 mg/l, respectively, at 96 hours (Segna, 1981). Tests for carcinogenicity were shown to have positive results (NIOSH, 1979).

SWEP has not been monitored in the pesticide industry. SWEP is a pre- and post-emergence herbicide used to control seedlings of annual weeds and grasses in rice and large-seeded legumes. It is a white solid with a melting point of 112° to 114°C. SWEP is practically insoluble in water. The acute oral LD50 is 552 mg/kg for rats, and the acute dermal LD50 for rabbits is more than 2,480 mg/kg (Martin and Worthing, 1977).

Raw waste load concentrations of 2,4,5-T have been monitored at levels which are declared proprietary. 2,4,5-T is a herbicide used to kill woody plants. It is applied as a foliage, dormant shoot, or bark spray. Two methods of application of 2,4,5-T are girdling and direct plant injection. 2,4,5-T acid exists in the form of white crystals with a solubility in water of 278 mg/l at 25°C. 2,4,5-T salts are water soluble; however, esters of 2,4,5-T are insoluble in water (Martin and Worthing, 1977). The acute oral LD50 for dogs is 100 mg/kg (Martin and Worthing, 1977). An increased incidence of tumors was observed at various sites in mice when 2,4,5-T was administered orally and dermally (Vettorazzi, 1979). The LC50 for the most sensitive organism reported (lobo salmon; freshwater) is greater than 10 mg/l at 96 hours (Piecuch, 1981). 2,4,5-T is suspected of being carcinogenic (NIOSH, 1979). The predicted BCF value for 2,4,5-T is 28 (Kenaga, 1979).

Terbacil has not been monitored in the pesticide industry. Terbacil is a herbicide which acts as an inhibitor of photosynthesis. It is absorbed by roots and translocates to leaves. Terbacil is used for control of many annual and some perennial weeds in crops such as sugar cane, apples, peaches, citrus, and mint. It is a white crystalline solid with a solubility in water of 710 mg/l at 25°C. The acute oral LD50 is greater than 5,000 mg/kg for rats (Martin and Worthing, 1977). Terbacil is persistent in the soil and has an average half-life of several months (McEwen and Stephenson, 1979). The LC50 for the rainbow trout (freshwater) is 54.0 mg/l at 96 hours (EPA, OPP). The predicted BCF value for terbacil is 15 (Kenaga, 1979).

Raw waste load concentrations of terbufos have been monitored at levels which are declared proprietary. Terbufos is a soil-applied insecticide with residual action. It is used on cotton, sugar beets, cabbage, and onions. The technical product is a clear, colorless to pale yellow

liquid with a boiling point of 69°C. Terbufos is soluble in water at a rate of 10 mg/l to 15 mg/l at room temperature. Terbufos is extremely toxic to mammals. The acute oral LD50 is 1.6 mg/kg to 4.5 mg/kg for male albino rats, and the acute dermal LD50 is 1.0 mg/kg to 7.4 mg/kg for albino rats and rabbits. Long-term feeding studies of dogs, mice, and rats showed depression of cholinesterase activity (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 0.013 mg/l and 0.068 mg/l, respectively, at 96 hours (Segna, 1981). The predicted BCF value for terbufos is 152 (Kenaga, 1979).

Terbuthylazine has not been monitored in the pesticide industry. Terbuthylazine is a herbicide which is taken up by roots and controls a wide range of weeds. It is used as a pre-emergence herbicide in sorghum and for selective weed control in corn, vineyards, and citrus. Terbuthylazine is a white solid which is soluble in water at a rate of 8.5 mg/l at 20°C. The acute oral LD50 is 2,160 mg/kg for rats, and the acute dermal LD50 of an 80 percent formulation is 10,200 mg/kg for rabbits. Terbuthylazine is toxic to quail, ducks, carp, catfish, and trout (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.013 mg/l at 96 hours (Segna, 1981).

Terbutryn has not been monitored in the pesticide industry. Terbutryn is a selective pre- and post-emergence herbicide for use on winter cereals, sunflowers, potatoes, and peas. It is a white powder with a melting point of 104° to 105°C. Terbutryn is soluble in water at a rate of 58 mg/l at 20°C (Martin and Worthing, 1977). Terbutryn is toxic to trout, carp, catfish, bluegill, sunfish, and birds. The acute oral LD50 is 2,400 mg/kg to 2,980 mg/kg for rats and 4,000 mg/kg for hens (Martin and Worthing, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 2.70 mg/l and 0.82 mg/l, respectively, at 96 hours (U.S. Fish and Wildlife Service, 1980). The predicted BCF value for terbutryn is 100 (Kenaga, 1979).

Triademefon has not been monitored in the pesticide industry. Triademefon is a systemic fungicide which has protective action. It is used against mildew and rusts on vegetables, cereals, coffee, and grapes. Triademefon is a colorless solid with a melting point of 83.3°C. Its solubility in water is 250 mg/l at 20°C (Martin and Worthing, 1977). Triademefon is toxic to fish and mammals. The TLM (96-hour) for Carassius auratus is 10 mg/l to 50 mg/l. The acute oral LD50 is 363 mg/kg for female rats, and the acute dermal LD50 is more than 1,000 mg/kg for rats (Martin and Worthing, 1977).

Tributyltin benzoate has not been monitored in the pesticide industry. Tributyltin benzoate is a fungicide used mainly on leather and textiles (Packer, 1975). The oral LD50 for rats is 132 mg/kg (NIOSH, 1977). The LC50 for the bluegill (freshwater) is 0.064 mg/l at 96 hours (EPA, OPP).

Tributyltin oxide has not been monitored in the pesticide industry. Tributyltin oxide is a fungicide used in lumber, paint, plastics, and fabrics (Packer, 1975). The oral LD50 is 87 mg/kg for rats (NIOSH, 1977). The LC50 for the most sensitive organism reported (Daphnia; saltwater) is 0.00167 mg/l at 96 hours (Segna, 1981). The LC50s for bluegill and rainbow trout (freshwater) are 0.0076 mg/l and 0.0056 mg/l, respectively, at 96 hours (Segna, 1981).

Trichloronate has not been monitored in the pesticide industry. Trichloronate is a nonsystemic insecticide. The acute oral LD50 is 16 mg/kg to 37 mg/kg for rats (Worthing, 1979).

Tricyclazole has not been monitored in the pesticide industry. Tricyclazole is a fungicide used on rice for the control of blast disease. It is a crystalline solid with a melting point of 187° to 188°C. Tricyclazole is soluble in water at a rate of 1.6 g/l at 25°C (Martin and Worthing, 1977). Tricyclazole is very toxic to fish. The TLMs (96-hour) for rainbow trout and bluegill sunfish are 1.62 mg/l and 1.96 mg/l, respectively. This compound is also toxic to mammals. The acute oral LD50 is 250 mg/kg for mice (Martin and Worthing, 1977).

Raw waste load concentrations of trifluralin have been monitored at levels which are declared proprietary. Trifluralin is a pre-emergence herbicide with some post-emergence activity when incorporated in the soil (Martin and Worthing, 1977). It is absorbed by penetrating shoots and roots of young seedlings and inhibits growth in the entire seedling, especially in lateral root formation (McEwen and Stephenson, 1979). It is used to control broad-leaved weeds and annual grasses in cotton legumes, beans, and orange trees. Trifluralin is an orange, crystalline solid with a melting point of 48.5° to 49°C. Its solubility in water is less than 1 mg/l at 27°C (Martin and Worthing, 1977). Trifluralin is toxic to fish. The LC50 for bluegills is 0.058 ppm and for goldfish 0.056 ppm (McEwen and Stephenson, 1979). The acute oral LD50 for dogs, rabbits, and chickens is greater than 2,000 mg/kg (Martin and Worthing, 1977). Trifluralin is very persistent in the environment due to its immobility in soil caused by its low solubility in water and tendency to absorb to soil particles (McEwen and Stephenson, 1979). Trifluralin is persistent in soil up to 1 year (Martin and Worthing, 1977). The LC50 for the most sensitive organism reported (rainbow trout; freshwater) is 0.041 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). The LC50 for the bluegill (freshwater) is 0.058 mg/l at 96 hours (U.S. Fish and Wildlife Service, 1980). Trifluralin showed positive results in tests for carcinogenicity (NIOSH, 1979). The calculated BCF value for trifluralin is 4,570 (Kenaga, 1979).

Vancide 51Z has not been monitored in the pesticide industry. Vancide 51Z is a fungicide. The oral LD50 is 540 mg/kg for rats. The subcutaneous TDlo is 1,000 mg/kg (NIOSH, 1977).

Vancide 51Z dispersion has not been monitored in the pesticide industry. See vancide 51Z for environmental and health effects.

Vancide TH has not been monitored in the pesticide industry. Vancide TH is a fungicide for mold control in coolants and cutting. The acute oral LD50 is 316 mg/kg for rats (NIOSH, 1977). The LC50s for the bluegill and rainbow trout (freshwater) are 39.9 mg/l and 25.2 mg/l, respectively, at 96 hours (Segna, 1981).

Raw waste load concentrations of ZAC have been monitored at levels which are declared proprietary. ZAC is a nonsystemic fungicide used for foliage application. Information on environmental and health effects was not available at time of publication.

Raw waste load concentrations of zineb have been monitored at levels which are declared proprietary. Zineb is a fungicide used to protect foliage and is phytotoxic to zinc-sensitive plants. Zineb is a light-colored powder which is soluble in water at a rate of 10 mg/l at room temperature (Martin and Worthing, 1977). The acute oral LD50 is more than 5,000 mg/kg for rats (Martin and Worthing, 1977). The chemical breakdown of zineb produces ethylenethiourea (ETU), ethylene thiuram monosulfide, and ethylenediamine. ETU has been shown to produce tumors in the thyroid gland. An increased incidence of lung tumors was observed in studies of mice which were fed sublethal doses of zineb. Dermally applied, zineb also produced tumors in mice. It is recommended that man's daily intake of zineb should not exceed 0.005 mg/kg (Vettorazzi, 1979). The LC50s for the bluegill and rainbow trout (freshwater) are greater than 180 mg/l and 20.8 mg/l, respectively, at 96 hours (Segna, 1981). Zineb is suspected of being a carcinogen (NIOSH, 1979).

Ziram has not been monitored in the pesticide industry. Ziram is a protective fungicide used on fruit and vegetable crops and is phytotoxic to zinc-sensitive plants. Ziram is a white, odorless powder with a melting point of 240°C. Its solubility in water is 65 mg/l at 25°C (Martin and Worthing, 1977). The acute oral LD50 for rats is 1,400 mg/kg. It has been shown that ziram can cause irritation of the skin and mucous membranes (Martin and Worthing, 1977). Rats demonstrate an increase in the skeletal stores of iron when fed sublethal doses of ziram. Ziram has caused adenomas in mice and increased incidence of tumors in the liver and under the skin of rats. Ziram can react with nitrate under mildly acid conditions to form N-nitrosodimethylamine, which is a proven carcinogen in several animal species. It has been recommended that man's daily intake of ziram should not exceed 0.02 mg/kg (Vettorazzi, 1979). The LC50 for the rainbow trout (freshwater) is greater than 0.3 mg/l at 96 hours (Segna, 1981). Ziram is suspected of being a carcinogen (NIOSH, 1979).

Secondary Significance--Nonconventional pesticide pollutants which currently lack approved analytical methods and/or adequate technical and economic data are proposed to be excluded from regulation at this time. However, if approved analytical methods and/or adequate data become available, it is proposed that regulation of these pollutants be implemented.

Additional Nonconventional Pollutants

Primary Significance--The nonconventional pollutant COD is proposed to be classified as a pollutant of primary significance. The chemical oxygen demand (COD) determination provides a measure of the oxygen equivalent of that portion of the organic matter in a sample that is susceptible to chemical oxidation. The carbonaceous portion of nitrogenous compounds can be determined by the COD test, and there is questionable reduction of the dichromate by ammonia. With certain wastes containing toxic substances, this test or a total organic carbon (TOC) determination may be the best method for determination of the organic load. Since the test utilizes chemical oxidation rather than a biological process, the result is not always exactly related to the BOD of a wastewater. The test result should be considered as an independent measurement of organic matter in the sample, rather than as a substitute for the BOD test (Jett, 1978).

Secondary Significance--The pollutant manganese is proposed to be designated as a nonconventional pollutant of secondary significance. Its importance is derived from the fact that it is being considered for addition to the list of 126 priority pollutants. Therefore, a guidance number is being proposed to limit its discharge from the pesticide industry on a case-by-case basis. In the pesticide industry, manganese can be expected to be present in wastewaters from dithiocarbamate pesticides such as maneb. Manganese raw waste load concentrations as high as 484 mg/l have been observed in raw waste loads. Manganese may interfere with water usage since it stains materials, especially when the pH is raised as in laundering, scouring, or other washing operations. These stains, if not masked by iron, may be dirty brown, gray, or black in color, and usually occur in spots and streaks. Waters containing manganous bicarbonate cannot be used in the textile industries, in dyeing, tanning, laundering, or in many other industrial uses. In the pulp and paper industry, waters containing above 0.05 mg/l manganese cannot be tolerated except for low-grade products. Very small amounts of manganese (0.2 mg/l to 0.3 mg/l) may form heavy encrustations in piping, while even smaller amounts may form noticeable black deposits (U.S. EPA, 1976g).

It is proposed that ammonia be designated a nonconventional pollutant of secondary significance. In the pesticide industry, ammonia nitrogen may be found in raw waste loads up to levels of 1,500 mg/l at individual plants. Ammonia is not a universal pollutant for this industry and, therefore, a guidance number is being proposed to limit its discharge on an individual basis. Ammonia is a form of nitrogen that readily fulfills the nutrient requirement of aquatic plants. In those cases where adequate phosphorus is available, nitrogen may be the limiting nutrient. In such a case, the discharge of wastewaters containing ammonia will contribute to eutrophication of the receiving water and consequent nuisance aquatic plant growth. Ammonia can also be toxic to aquatic animals (U.S. EPA, 1976g). The toxicity of ammonium solutions is dependent upon the amount of ammonia, the concentrations of which vary with the pH of the water. In most natural waters the pH range is such that ammonium ions predominate; however, in alkaline waters high

concentrations of ammonia increase the toxicity. EPA has recommended a maximum acceptable concentration of ammonia of 0.02 mg/l in waters suitable for aquatic life (U.S. EPA, 1976g).

Conventional Pollutants

The conventional pollutants BOD, TSS, and pH are classified as pollutants of primary significance. There are no conventional pollutants of secondary significance.

The BOD test is essentially a bioassay procedure involving the measurement of oxygen consumed by living organisms while utilizing the organic matter present in a wastewater under conditions as similar as possible to those that occur in nature. Historically, the BOD test has been used to evaluate the performance of biological wastewater treatment facilities and to establish effluent limitation values. It is important to note that most state, local, and regional authorities have established water quality regulations utilizing BOD as the major parameter for determination of oxygen demand on a water body. When properly performed, the BOD test measures the actual amount of oxygen consumed by microorganisms in metabolizing the organic matter present in the wastewater.

Total suspended solids (TSS) is a measure of suspended solids which are usually composed of organic and inorganic fractions. These fractions, in turn, may be made up of readily settleable, slowly settleable, or nonsettleable materials. The biodegradable organic fraction will exert an oxygen demand on a receiving water and is reflected in the analyses for organics.

Suspended solids in water interfere with many industrial processes, causing foaming in boilers and incrustations on equipment exposed to such water, especially as the temperature rises. They are undesirable in process water used in the manufacture of steel, in the textile industry, in launderies, in dyeing, and in cooling systems.

When solids settle to form sludge deposits on a stream or lake bed, they are often damaging to the life in water. Sludge deposits may cause various damage, including blanketing the stream or lake bed and thereby destroying the living spaces for those benthic organisms that would otherwise occupy the habitat. Organic materials also serve as a food source for sludgeworms and associated organisms.

Solids in suspension are aesthetically displeasing. Suspended solids may kill fish and shellfish by causing abrasive injuries and by clogging the gills and respiratory passages. Indirectly, suspended solids are inimical to aquatic life because they screen out light and promote and maintain the development of noxious conditions through oxygen depletion. This results in the killing of fish and fish food organisms. Suspended solids also reduce the recreational value of the water.

The control of suspended solids from biological treatment systems is especially critical. Not only does the biomass exert an oxygen demand

on receiving waters, but for the Pesticide Chemicals Industry there is evidence that substantial quantities of toxic residues are absorbed on or in the floc which, if carried over, will potentially cause a toxic effect in the receiving waters.

The pH is a logarithmic measure of the acidity or alkalinity of a wastewater stream. It may properly be used as a surrogate to control both excess acidity and excess alkalinity in water. The term pH is the negative logarithm of the hydrogen ion concentration in water. A pH of 7 generally indicates neutrality or a balance between free hydrogen and free hydroxyl ions. A pH above 7 indicates that a solution is alkaline, while a pH below 7 indicates that the solution is acidic.

Knowledge of the pH of water or wastewater is useful in determining necessary measures for corrosion control, pollution control, and disinfection. Waters with a pH below 6.0 are corrosive to water works structures, distribution lines, and household plumbing fixtures. Also, corrosion can add constituents such as iron, copper, zinc, cadmium, and lead to drinking water. Low pH waters not only tend to dissolve metals from structures and fixtures but also tend to dissolve or leach metals from sludges and bottom sediments. The hydrogen ion concentration can affect the "taste" of water and, at a low pH, water tastes "sour."

Extremes of pH or rapid pH changes can exert stress conditions or kill aquatic life outright. Even moderate changes from "acceptable" criteria limits of pH are deleterious to some species. The relative toxicity to aquatic life of many materials is increased by changes in the pH. For example, metallo-cyanide complexes can increase a thousand-fold in toxicity with a drop of 1.5 pH units. Similarly, the toxicity of ammonia is a function of pH. The bactericidal effect of chlorine is diminished as the pH increases in most cases. In addition, it is economically advantageous to keep the pH close to 7 (Jett, 1978).

Table IX-1. Proposed Pollutants of Primary Significance

Priority Pollutants	Nonconventional Pollutants	Conventional Pollutants
Volatile Aromatics	Nonconventional	BOD
Benzene	pesticides listed in	TSS
Chlorobenzene	Tables XII-1 and XIII-1	pH
Toluene	are designated noncon-	
Halomethanes	ventional pollutants of	
Carbon tetrachloride	primary significance	
Chloroform	COD	
Methyl bromide		
Methyl chloride		
Methylene chloride		
Cyanides		
Cyanide		
Phenols		
2,4-Dichlorophenol		
2,4-Dinitrophenol		
4-Nitrophenol		
Pentachlorophenol		
Phenol		
Metals		
Copper		
Zinc		
Chlorinated Ethanes		
1,2-Dichloroethane		
Tetrachloroethylene		
Nitrosamines		
N-nitrosodi-n-propylamine		
Pesticides		
BHC-alpha		
BHC-beta		
BHC-delta		
Endosulfan-alpha		
Endosulfan-beta		
Endrin		
Heptachlor		
Lindane (BHC-gamma)		
Toxaphene		
Dienes		
Hexachlorocyclopentadiene		

Table IX-2. Proposed Pollutants of Dual Significance

Priority Pollutants	Nonconventional Pollutants	Conventional Pollutants
Volatile Aromatics 1,2-Dichlorobenzene* 1,4-Dichlorobenzene* 1,2,4-Trichlorobenzene*	None	None
Haloethers Bis(2-chloroethyl) ether†		
Dichloropropane and Dichloropropene 1,3-Dichloropropene†		

* Classified as a priority pollutant of primary significance and proposed for regulation only if it is manufactured as a final product. Classified as a priority pollutant of secondary significance in other processes and proposed to be excluded from regulation since it is controlled by regulation of chlorobenzene.

† Classified as a priority pollutant of primary significance and proposed for regulation only if it is manufactured as a final product and has zero discharge. Classified as a priority pollutant of secondary significance in other processes and proposed to be excluded from regulation due to a lack of adequate monitoring and control data.

Table IX-3. Proposed Pollutants of Secondary Significance

Priority Pollutants	Nonconventional Pollutants	Conventional Pollutants
Volatile Aromatics	Nonconventional	None
1,3-Dichlorobenzene†	pesticides for which	
Ethylbenzene†	approved analytical	
Hexachlorobenzene†	procedures and/or	
Halomethanes	adequate technical	
Bromoform†	and economic data	
Chlorodibromomethane†	Ammonia*	
Dichlorobromomethane†	Manganese*	
Haloethers		
Bis(2-chloroethoxy) methane*		
Bis(2-chloroisopropyl) ether*		
4-Bromophenyl phenyl ether*		
2-Chloroethyl vinyl ether*		
4-Chlorophenyl phenyl ether*		
Phenols		
2-Chlorophenol†		
2,4-Dimethylphenol†		
4,6-Dinitro-o-cresol†		
2-Nitrophenol†		
Parachlorometa cresol†		
2,4,6-Trichlorophenol†		
Nitrosubstituted Aromatics		
2,4-Dinitrotoluene†		
2,6-Dinitrotoluene†		
Nitrobenzene†		
Polynuclear Aromatic Hydrocarbons		
Acenaphthylene*		
Acenaphthene*		
Anthracene*		
Benzo(a)anthracene†		
Benzo(a)pyrene†		
3,4-Benzofluoranthene†		
Benzo(ghi)perylene†		
Benzo(k)fluoranthene†		
2-Chloronaphthalene*		
Chrysene†		
Dibenzo(a,h)anthracene†		
Fluoranthene*		
Fluorene*		
Indeno(1,2,3-cd)pyrene†		
Naphthalene*		
Phenanthrene*		
Pyrene†		

Table IX-3. Proposed Pollutants of Secondary Significance
(Continued, Page 2 of 2)

Priority Pollutants	Priority Pollutants
Metals	Pesticides
Antimony†	Aldrin†
Arsenic*	Chlordane*
Beryllium†	Dieldrin†
Cadmium†	4,4'-DDD†
Chromium†	4,4'-DDE†
Lead†	4,4'-DDT†
Mercury†	Endosulfan sulfate†
Nickel†	Endrin aldehyde†
Selenium†	Heptachlor epoxide†
Silver†	Dienes
Thallium†	Hexachlorobutadiene†
Chlorinated Ethanes and Ethylenes	TCDD
Chloroethane†	TCDD*
1,1-Dichloroethane†	Miscellaneous
1,1-Dichloroethylene†	Acrolein†
Hexachloroethane†	Acrylonitrile*
1,1,2,2-Tetrachloroethane†	Asbestos†
1,2-Trans-dichloroethylene†	1,2-Diphenylhydrazine†
1,1,1-Trichloroethane†	Isophorone†
1,1,2-Trichloroethane†	Polychlorinated Biphenyls
Trichloroethylene†	PCB-1242†
Vinyl chloride†	PCB-1254†
Nitrosamines	PCB-1221†
N-nitrosodimethylamine†	PCB-1232†
N-nitrosodiphenylamine†	PCB-1248†
Phthalate Esters	PCB-1260†
Bis(2-ethylhexyl) phthalate†	PCB-1016†
Butyl benzyl phthalate*	Benzidines
Diethyl phthalate*	Benzidine†
Dimethyl phthalate*	3,3'-Dichlorobenzidine†
Di-n-butyl phthalate*	Dichloropropane and Dichloropropene
Di-n-octyl phthalate†	1,2-Dichloropropane*

* Proposed to be excluded from regulation pending the collection of adequate monitoring and control data.
† Proposed to be excluded from regulation.

Table IX-4. Volatile Aromatics Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Benzene	NA	NA	NA	NA	5,300	NA	5,100	NA	6.6**	400
Chlorobenzene	NA	NA	NA	NA	250*	NA	160*	129*	488	15,050
1,2-Dichlorobenzene	NA	NA	NA	NA	1,120†	763†	1,970†	NA	400†	2,600†
1,3-Dichlorobenzene	NA	NA	NA	NA	1,120†	763†	1,970†	NA	400†	2,600†
1,4-Dichlorobenzene	NA	NA	NA	NA	1,120†	763†	1,970†	NA	400†	2,600†
Ethylbenzene	NA	NA	NA	NA	32,000	NA	430	NA	1,400	3,280
Hexachlorobenzene	NA	NA	NA	NA	250*	NA	160*	129*	0.0072	0.0074
1,2,4-Trichlorobenzene	NA	NA	NA	NA	250*	286	160*	129*	NA	NA
Toluene	NA	NA	NA	NA	17,500	NA	6,300	5,000	14,300	424,000

NA = Not available.
* = Value reported for the chlorinated benzenes group.
† = Value reported for the dichlorobenzenes group.
** = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-5. Halomethanes Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Bromoform	NA	NA	NA	NA	11,000*	NA	12,000*	6,400*	1.9*†	157*†
Carbon tetrachloride	NA	NA	NA	NA	35,700*	NA	50,000	NA	4.0†	69.4†
Chlorodibromomethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Chloroform	NA	NA	NA	NA	28,900	1,240	NA	NA	1.9*†	157*†
Dichlorobromomethane	NA	NA	NA	NA	11,000*	NA	12,000*	6,400*	1.9*†	157*†
Methyl bromide	NA	NA	NA	NA	11,000*	NA	12,000*	6,400*	1.9*†	157*†
Methyl chloride	NA	NA	NA	NA	11,000*	NA	12,000*	6,400*	1.9*†	157*†
Methylene chloride	NA	NA	NA	NA	11,000*	NA	12,000*	6,400*	1.9*†	157*†

NA = Not available.
* = Value reported for the halomethane group.
† = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-6. Cyanide Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Cyanide	3.5	52	NA	NA	NA	NA	30	2.0	200	200

NA = Not available.

Table IX-7. Haloethers Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Bis(2-chloroethoxy) methane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Bis(2-chloroethyl) ether	NA	NA	NA	NA	238,000*	NA	NA	NA	0.30**	13.6**
Bis(2-chloroisopropyl) ether	NA	NA	NA	NA	238,000*	NA	NA	NA	34.7	4,360
4-Bromophenyl phenyl ether	NA	NA	NA	NA	360†	122†	NA	NA	NA	NA
2-Chloroethyl vinyl ether	NA	NA	NA	NA	354,000	NA	NA	NA	NA	NA
4-Chlorophenyl phenyl ether	NA	NA	NA	NA	360†	122†	NA	NA	NA	NA

NA = Not available.
* = Value reported for the chloroakyl ethers group.
† = Value reported for the haloethers group.
** = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-8. Phenols Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
2-Chlorophenol	NA	NA	NA	NA	4,380	NA	NA	NA	NA	NA
2,4-Dichlorophenol	NA	NA	NA	NA	2,070	365	NA	NA	3,090	NA
2,4-Dimethylphenol	NA	NA	NA	NA	2,120	NA	NA	NA	NA	NA
4,6-Dinitro-o-cresol	NA	NA	NA	NA	NA	NA	NA	NA	13.4	765
2,4-Dinitrophenol	NA	NA	NA	NA	620	NA	7,900	7,900	70	14,300
2-Nitrophenol	NA	NA	NA	NA	230*	NA	4,850	NA	NA	NA
4-Nitrophenol	NA	NA	NA	NA	230*	NA	27,100	12,650	NA	NA
Parachlorometa cresol	NA	NA	NA	NA	30	NA	NA	NA	NA	NA
Pentachlorophenol	NA	NA	NA	NA	55	3.2	53	34	1,010	NA
Phenol	NA	NA	NA	NA	10,200	2,560	5,800	NA	3,500	NA
2,4,6-Trichlorophenol	NA	NA	NA	NA	NA	970	NA	NA	12†	36†

NA = Not available.
* = Value reported for the phenols group.
† = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-9. Nitrosubstituted Aromatics Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
2,4-Dinitrotoluene	NA	NA	NA	NA	330*	230*	590*	NA	1.1†	91†
2,6-Dinitrotoluene	NA	NA	NA	NA	330*	230*	590*	NA	NA	NA
Nitrobenzene	NA	NA	NA	NA	27,000	NA	6,680	NA	19,800	NA

NA = Not available.
* = Value reported for the dinitrosubstituted aromatics group.
† = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-10. Polynuclear Aromatic Hydrocarbons Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Acenaphthylene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Acenaphthene	NA	NA	NA	NA	1,700	NA	970	710	0.028*†	0.311*†
Anthracene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Benzo(a)anthracene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Benzo(a)pyrene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
3,4-Benzofluoranthene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Benzo(ghi)perylene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Benzo(k)fluoranthene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
2-Chloronaphthalene	NA	NA	NA	NA	1,600	NA	7.5	NA	NA	NA
Chrysene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Dibenzo(a,h)anthracene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Fluoranthene	NA	NA	NA	NA	3,980	NA	40	16	42	54
Fluorene	NA	NA	NA	NA	NA	NA	1,000	NA	0.028*†	0.311*†
Indeno(1,2,3-cd)pyrene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†
Naphthalene	NA	NA	NA	NA	2,300	620	2,350	NA	NA	NA
Phenanthrene	NA	NA	NA	NA	NA	NA	600	NA	0.028*†	0.311*†
Pyrene	NA	NA	NA	NA	NA	NA	300*	NA	0.028*†	0.311*†

NA = Not available.
* = Value reported for the polynuclear aromatic hydrocarbon group.
† = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-11. Metals Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Antimony	NA	NA	NA	NA	9,000	1,600	NA	NA	146	45,000
Arsenic	NA	440	NA	NA	NA	NA	508	NA	0.022†	0.175†
Beryllium	NA	NA	NA	NA	130	5.3	NA	NA	0.037†	0.641†
Cadmium	0.012*	1.5*	4.5	59	NA	NA	NA	NA	NA	NA
Chromium	0.29	21	18	1,260	NA	NA	10,300	NA	170,000	3,433,000
Copper	5.6	12*	4.0	23	NA	NA	NA	NA	NA	NA
Lead	0.75*	74*	NA	NA	NA	NA	668	25	NA	NA
Mercury	0.00057	0.0017	0.025	3.7	NA	NA	NA	NA	0.144	0.146
Nickel	56*	1,100*	7.1	140	NA	NA	NA	NA	13.4	100
Selenium	35	260	54	410	760	NA	NA	NA	NA	NA
Silver	NA	1.2	NA	2.3	NA	0.12	NA	NA	NA	NA
Thallium	NA	NA	NA	NA	1,400	40	2,130	NA	13	48
Zinc	47	180	58	170	NA	NA	NA	NA	NA	NA

NA = Not available.

* = Based on a hardness of 50 mg/l as $CaCO_3$.

† = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-12. Chlorinated Ethanes and Ethylenes Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Chloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,1-Dichloroethane	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1,2-Dichloroethane	NA	NA	NA	NA	118,000	20,000	113,000	NA	9.4**	2,430**
1,1-Dichloroethylene	NA	NA	NA	NA	11,600*	NA	224,000	NA	0.33**	18.5**
Hexachloroethane	NA	NA	NA	NA	980	540	940	NA	19**	87.4**
1,1,2,2-Tetrachloroethane	NA	NA	NA	NA	9,320	2,400	9,020	NA	1.7**	107**
Tetrachloroethylene	NA	NA	NA	NA	5,280	840	10,200	450	8.0**	88.5**
1,2-Trans-dichloroethylene	NA	NA	NA	NA	11,600*	NA	NA	NA	NA	NA
1,1,1-Trichloroethane	NA	NA	NA	NA	18,000†	NA	31,200	NA	18,400	1,030,000
1,1,2-Trichloroethane	NA	NA	NA	NA	18,000†	9,400	NA	NA	6.0**	418**
Trichloroethylene	NA	NA	NA	NA	45,000	21,900	2,000	NA	27**	807**
Vinyl chloride	NA	NA	NA	NA	NA	NA	NA	NA	20**	5,246**

NA = Not available.
* = Value reported for the dichloroethane group.
† = Value reported for the trichloroethane group.
** = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-13. Nitrosamines Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
N-nitrosodimethylamine	NA	NA	NA	NA	5,850*	NA	3,300,000*	NA	0.014	160
N-nitrosodiphenylamine	NA	NA	NA	NA	5,850*	NA	3,300,000*	NA	49.0	161
N-nitrosodi-n-propylamine	NA	NA	NA	NA	5,850*	NA	3,300,000*	NA	0.008*	12.4*

NA = Not available.
* = Value reported for the nitrosamines group.

Table IX-14. Phthalate Esters Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Bis(2-ethylhexyl) phthalate	NA	NA	NA	NA	940*	3*	2,944*	NA	15,000	50,000
Butyl benzyl phthalate	NA	NA	NA	NA	940*	3*	2,944*	NA	NA	NA
Diethyl phthalate	NA	NA	NA	NA	940*	3*	2,944*	NA	350,000	1,800,000
Dimethyl phthalate	NA	NA	NA	NA	940*	3*	2,944*	NA	313,000	2,900,000
Di-n-butyl phthalate	NA	NA	NA	NA	940*	3*	2,944*	NA	34,000	154,000
Di-n-octyl phthalate	NA	NA	NA	NA	940*	3*	2,944*	NA	NA	NA

NA = Not available.
* = Value reported for the phthlate esters group.

Table IX-15. Dichloropropane and Dichloropropene Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
1,2-Dichloropropane	NA	NA	NA	NA	23,000	5,700	103,000	3,040	NA	NA
1,3-Dichloropropene	NA	NA	NA	NA	6,060	244	790	NA	87	14,100

NA = Not available.

Table IX-16. Priority Pollutant Pesticides Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Aldrin	NA	3.0	NA	1.3	NA	NA	NA	NA	0.00074	0.00079
A-BHC-Alpha	NA	NA	NA	NA	100†	NA	0.34†	NA	0.092	0.310
B-BHC-Beta	NA	NA	NA	NA	100†	NA	0.34†	NA	0.163	0.547
R-BHC-Gamma	0.080	2.0	NA	0.16	NA	NA	NA	NA	0.186	0.625
G-BHC-Delta	NA	NA	NA	NA	100†	NA	0.34†	NA	NA	NA
Chlordane	0.0043	2.4	0.0040	0.09	NA	NA	NA	NA	0.0046	0.0048
Dieldrin	0.0019	2.5	0.0019	0.41	NA	NA	NA	NA	0.00071	0.00076
4,4'-DDD	NA	NA	NA	NA	0.6	NA	3.6	NA	NA	NA
4,4'-DDE	NA	NA	NA	NA	1,050	NA	14	NA	NA	NA
4,4'-DDT	0.0010	1.1	0.0010	0.13	NA	NA	NA	NA	0.00024	0.00024
A-Endosulfan-Alpha	0.056*	0.22*	0.0087*	0.034*	NA	NA	NA	NA	74*	159*
B-Endosulfan-Beta	0.056*	0.22*	0.0087*	0.034*	NA	NA	NA	NA	74*	159*
Endosulfan sulfate	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Endrin	0.0023	0.18	0.0023	0.037	NA	NA	NA	NA	1.0	NA
Endrin aldehyde	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Heptachlor	0.0038	0.52	0.0036	0.053	NA	NA	NA	NA	0.00278	0.00285
Heptachlor epoxide	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Toxaphene	0.013	1.6	NA	0.070	NA	NA	NA	NA	0.0071	0.0073

NA = Not available.
* = Value reported for the endosulfan group.
† = Value reported for the BHC byproduct group.

Table IX-17. Dienes Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Hexachlorobutadiene	NA	NA	NA	NA	90	9.3	32	NA	4.47*	500*
Hexachlorocyclopentadiene	NA	NA	NA	NA	70	5.2	7.0	NA	206	NA

NA = Not available.

* = Based on an icremental lifetime increased cancer risk of 10^{-5}.

Table IX-18. TCDD Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
TCDD	NA	NA	NA	NA	0.000056*	NA	NA	NA	NA	NA

TCDD = 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
* = Based on a 12 percent mortality after 60 days exposure.
NA = Not available.

Table IX-19. Miscellaneous Priority Pollutants Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Acrolein	NA	NA	NA	NA	68	21	55	NA	320	NA
Acrylonitrile	NA	NA	NA	NA	7,550	2,600*	NA	NA	0.58†	6.5†
Asbestos	NA	NA	NA	NA	NA	NA	NA	NA	300,000 Fibers†	NA
1,2-Diphenylhydrazine	NA	NA	NA	NA	270	NA	NA	NA	0.422†	5.6†
Isophorone	NA	NA	NA	NA	117,000	NA	12,900	NA	5,280	520

NA = Not available.
* = Based on a 30 day exposure time.
† = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
PCB-1242	0.014*	NA	0.030*	NA	2.0*	NA	10*	NA	0.00079†*	0.00079†*
PCB-1254	0.014*	NA	0.030*	NA	2.0*	NA	10*	NA	0.00079†*	0.00079†*
PCB-1221	0.014*	NA	0.030*	NA	2.0*	NA	10*	NA	0.00079†*	0.00079†*
PCB-1232	0.014*	NA	0.030*	NA	2.0*	NA	10*	NA	0.00079†*	0.00079†*
PCB-1248	0.014*	NA	0.030*	NA	2.0*	NA	10*	NA	0.00079†*	0.00079†*
PCB-1260	0.014*	NA	0.030*	NA	2.0*	NA	10*	NA	0.00079†*	0.00079†*
PCB-1016	0.014*	NA	0.030*	NA	2.0*	NA	10*	NA	0.00079†*	0.00079†*

NA = Not available.
* = Value reported for the polychlorinated biphenyl group.
† = Based on an incremental lifetime increased cancer risk of 10^{-5}.

Table IX-21. Benzidines Water Quality Criteria

Priority Pollutant	Aquatic Life Criteria (ug/l)				Lowest Reported Toxic Concentration (ug/l)				Human Health Criteria (ug/l)	
	Freshwater		Saltwater		Freshwater		Saltwater			
	24-hour average	Not to be exceeded at any time	24-hour average	Not to be exceeded at any time	Acute	Chronic	Acute	Chronic	Ingesting water and organisms	Ingesting Organisms
Benzidine	NA	NA	NA	NA	2,500	NA	NA	NA	0.0012*	0.0053*
3,3'-Dichlorobenzidine	NA	NA	NA	NA	NA	NA	NA	NA	0.103*†	0.204*†

NA = Not available.
* = Based on an incremental lifetime increased cancer risk of 10^{-5}.
† = Value reported for the dichlorobenzidine group.

SECTION X

EXPANDED BEST PRACTICABLE TECHNOLOGY CURRENTLY AVAILABLE (BPT)

Sections 301 and 304 of the Act require that there be achieved, not later than July 1, 1984, effluent limitations for categories and classes of point sources, other than publicly owned treatment works, that require the application of the Best Practicable Control Technology currently available.

As stated in Section III of this document, all pesticide manufacturers were regulated for the direct discharge of conventional pollutants (BOD, TSS, pH) and COD during the initial BPT rulemaking process except for 23 pesticides and two classes of pesticides which were specifically excluded from coverage for any parameter (see Section XXI—Appendix 2 for a list of these pesticides). These pesticide products were excluded from the initial BPT regulation due to lack of adequate monitoring data and/or EPA/EMSL approved 304(h) analytical methods.

POLLUTANT PARAMETERS PROPOSED FOR REGULATION

The current study has generated additional data such that expanded BPT effluent limitations guidelines for the direct discharge of three conventional pollutants and COD are being proposed for 19 of the previously excluded nonconventional pesticides and two classes of nonconventional pesticides. Table X-1 lists the nonconventional pesticides proposed for regulation of conventional pollutants and COD under expanded BPT. Three of the 23 original pesticides will continue to remain excluded, since two are classified as plant growth regulators (gibberellic acid and naphthalene acetic acid) and dimethyl phthalate is expected to be regulated under another industry. One of the original 23 pesticides was erroneously listed under both the trade name, bisethylxanthogen, and the common name, EXD. This compound will be regulated under expanded BPT under its common name.

IDENTIFICATION OF EXPANDED BPT LIMITATIONS

The derivation of expanded BPT limitations includes identifying technology options, selecting options based on economic and technical aspects of implementing the regulation, selection of long-term averages, and determining daily and monthly variability.

Expanded BPT Control Technology Options

As presented below, various methods were identified for control of conventional pollutants and COD under expanded BPT.

Option 1--

Option 1 provides that expanded BPT limitations be based on technology equal to that which formed the basis of the initial BPT regulation (pesticide removal by hydrolysis or carbon/resin adsorption followed by biological oxidation). This level of technology is currently installed and operating at all plants which manufacture the pesticides excluded from the initial BPT rulemaking; therefore, little or no economic impact is projected.

Option 2--

Option 2 provides for control of conventional pollutants and COD under expanded BPT limitations based on the initial BPT technology (pesticide removal and biological oxidation) followed by multimedia filtration. Implementation of this option would result in an incremental increase in annual costs for direct discharge plants manufacturing the pesticides included in the expanded BPT regulation. Implementation of this option would result in the following increment of pollutant removal beyond Option 1.

Pollutant	Pollutant Removal (lbs/year)
BOD	40,000
COD	460,000
TSS	96,400

Treatment cost estimates for this option are presented below:

	Economic Effect for Option 2
Number of Plants Affected	6
Number of Pesticides Affected	13
Capital Cost ($1000s)	1,260
Annual Cost ($1000s)	298

Selection of Expanded BPT Technology

Option 1 is proposed as the basis for expanded BPT effluent limitations. Implementation of this option would establish a uniform national guideline for the direct discharge of conventional pollutants and COD for the pesticide industry. While implementation of Option 2 would effect greater removal of these pollutants over Option 1, the associated costs would increase correspondingly, resulting in costs which are disproportionate to the effluent reduction benefits.

Selection of Long-Term Averages

Expanded BPT long-term averages for BOD, TSS, pH, and COD are proposed to be equivalent to BPT. The basis for this proposal is that current raw waste loads, type of treatment, and effluents achieved were examined and found to be equivalent for pesticides in both the expanded and

original BPT coverage. The long-term average for these pollutants is presented on Table X-2.

Treatment Variability

For the expanded BPT regulation, the variability of daily and monthly average discharge levels was considered equal to BPT variability. The basis for these factors is presented on pages 184-186 of EPA report number 440/1-78/060-e. The proposed factors for the conventional pollutants BOD and TSS and nonconventional pollutant COD are, therefore, as follows:

	Daily Variability Factor	Monthly Variability Factor
BOD	6.6	1.4
TSS	4.7	1.3
COD	1.6	1.2

Effluent Limitations

The proposed expanded BPT limitations for BOD, TSS, pH, and COD for nonconventional pesticides listed in Table X-1 are provided in Tables II-1 through II-3.

Table X-1. Nonconventional Pesticides Proposed for Regulation of Conventional Pollutants and COD Under Expanded BPT

Pesticide Name
Allethrin
Benzyl benzoate
Biphenyl
Chlorophacinone
Coumafuryl
Diphacinone
Endothall acid (Endothall)
EXD (Herbisan) (Bisethylxanthogen)
Glyphosate
Methoprene
1,8-Naphthalic anhydride
Phenylphenol
Piperonyl butoxide
Propargite
Quinomethionate
Resmethrin
Rotenone
Sodium phenylphenate (Phenylphenol sodium salt)
Sulfoxide
Triazine compounds (both symmetrical and asymmetrical)
Ametryne
Anilazine
Atrazine
Cyanazine
Hexazinone
Metribuzin
Prometon
Prometryn
Propazine
Simazine
Simetryne
Terbuthylazine
Terbutryn
Vancide TH
Warfarin and similar anticoagulants
Coumachlor
Coumatetralyl
Warfarin

Table X-2. Selected Long-Term Averages for Direct Discharge of BOD, TSS, pH, and COD

Pollutant Parameter	Long-Term Average (lb/1,000 lbs)
BOD	1.12
TSS	1.31
pH	*
COD	8.01

* The pH shall be between the values of 6.0 to 9.0.

SECTION XII

BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE (BAT)

The U.S. Environmental Protection Agency is proposing BAT effluent limitations which must be achieved by July 1, 1984 by the Pesticide Chemicals Industry. This regulation will be based on the best economically achievable control and treatment technology employed by a point source within the industrial category or subcategory, or by another industry from which technology is readily transferable. BAT may include process changes or internal controls, even when not common industry practice.

BAT emphasizes in-process controls, as well as control or additional treatment techniques employed at the end of the production process. In developing BAT effluent limitations, EPA considered:

1. The manufacturing processes employed,
2. The age and size of the equipment and facilities employed;
3. The location of manufacturing facilities,
4. Process changes,
5. The engineering aspects of the application of various types of control techniques,
6. The cost of achieving the effluent reduction resulting from application of the technology,
7. Nonwater quality environmental impact (including energy requirements), and
8. Other factors as identified in Section VII.

As a result of the Clean Water Act of 1977, the achievement of BAT has become the principal national means of controlling toxic water pollution. This level of technology considers those plant processes and control technologies which, at the pilot plant, semi-works, and other levels, have demonstrated both technological performances and economic viability at a level sufficient to reasonably justify investing in such facilities. It is the highest degree of control technology that has been achieved or has been demonstrated to be capable of being designed for plant-scale operation up to and including "no discharge" of process wastewater pollutants. Although economic factors are considered in this development, the costs of this level of control are intended to be for

the state-of-the-art of current technology, subject to limitations imposed by economic and engineering feasibility. There may be some technical risk, however, with respect to performance and certainty of costs. Therefore, some process development and adaptation may be necessary for application of a technology at a specific plant site.

Information presented in this section is being used by the Effluent Guidelines Division of EPA to propose BAT effluent limitations. The following items are presented:

1. Nonconventional pesticide parameters proposed to be regulated are defined.

2. Priority pollutant parameters proposed to be regulated are defined.

3. Treatment alternatives are defined and evaluated.

4. The economic effects of implementing the proposed BAT regulation are estimated.

NONCONVENTIONAL PESTICIDE PARAMETERS PROPOSED FOR REGULATION

The nonconventional pesticide parameters to be regulated under BAT are defined in Table XII-1. This list was developed by considering the following factors: (1) discharge status, (2) previous BPT regulations of the pesticide parameter, (3) availability of adequate analytical methods and technical and economic data, and (4) environmental and health effects of pesticide exposure. As described below, 101 pesticide wastewaters are currently proposed to be regulated for the pesticide parameter.

The first factor considered was discharge status. It was documented in Section VII that there are 29 pesticide active ingredients which have attained a zero discharge status for process wastewater. Since 27 of these 29 pesticides are nonconventional pesticide parameters, they are proposed for regulation to a zero discharge level.

It should be noted that one of these 27 compounds, barban, was previously regulated during BPT; however, due to its current zero-discharge status, it will be re-regulated. The regulation of 6 of the 27 zero-discharge pesticide active ingredients is limited to specific plants. Biphenyl, chloropicrin, 2,4-D isooctyl ester, sodium monofluoroacetate, tributyltin oxide, and ziram attain a zero-discharge status only for specific plants identified in Table XII-1. Producers of these six pesticides who do discharge wastewater are proposed to be regulated to levels other than zero if analytical methods are available (see 2,4-D isooctyl ester and ziram), pending further evaluation of the feasibility for them to achieve no discharge.

A second factor initially considered in defining nonconventional pesticide parameters to be regulated under BAT was the status of regulation under BPT. There are 36 nonconventional pesticides in the

scope of this study which were regulated under BPT for direct discharge. Therefore, these pesticides do not require re-regulation for the nonconventional pesticide parameter for existing direct discharges; however, they do require regulation for indirect discharge (see Section XIV, PSES/PSNS) and new source direct discharges (see Section XIII, NSPS).

A third factor considered was analytical methods and data availability. Analytical methods and adequate data are available for 76 nonconventional pollutant pesticides which were not regulated under BPT. Due to this availability of methods these 76 pesticides become part of the 101 pesticides to be regulated under BAT for the nonconventional pesticide parameter for direct discharge.

The availability of nonconventional pesticide analytical methods described above is outlined in Section XXI--Appendix 8. Methods which were developed by the Agency and its contractors are listed by pesticide in the first four columns of the appendix table as follows:

1. EPA promulgated 11/73 are those pesticide procedures identified in Federal Register 38, Number 75, Part II.

2. EPA proposed 12/79 are those pesticide active ingredient procedures identified in Federal Register 44, Number 233, Part III.

3. Methods in 304(h) review committee are those pesticides which will be proposed by EPA in the near future.

4. Verification contractor methods are those pesticide procedures developed by EPA contractors during this study. These methods are also being reviewed by the EPA-EMSL 304(h) committee.

As shown in Section XXI--Appendix 8, industry, literature, and other analytical methods are under review by the Agency. The Agency is evaluating industry methods for the regulation nonconventional pesticides as well as contractor and Agency developed methods.

There are 70 nonconventional pesticides for which analytical methods are in 304(h) review committee which are proposed for regulation. Six pesticides with industry methods (alachlor, bentazon, butachlor, glyphosate, mephosfolan, and terbufos) were evaluated according to production significance and methods acceptability and are proposed for regulation. All other pesticides for which only industry methods are available are not currently proposed for regulation.

In summary, 27 nonconventional pesticides which have attained a zero-discharge status and 76 previously unregulated pesticides (103 total) were considered for regulation of the nonconventional pesticide parameter under BAT. Because two pesticides, 2,4-D isooctyl ester and ziram, will be regulated both at zero discharge and a level other than zero for specific plants, the total number of discrete pesticides proposed for regulation of the nonconventional pesticide

parameter is reduced from 103 to 101. All 101 pesticides are listed in Table XII-1.

Ambient Water Quality Criteria (WQC) are not developed for nonconventional pesticides. However, LC_{50}/EC_{50} values (rainbow trout, bluegill sunfish, and Daphnia), as well as other human health or environmental risk indicators, have been presented in Section IX of this report for the above-mentioned nonconventional pesticides proposed for regulation.

PRIORITY POLLUTANT PARAMETERS PROPOSED FOR REGULATION

The priority pollutant parameters to be regulated under BAT are defined in Table XII-2. This proposal was based on consideration of the following factors: (1) discharge status, (2) previous regulations of the priority pollutant pesticide parameter, (3) availability of adequate analytical methods, and (4) environmental and health effects of priority pollutant exposure. There are 25 priority pollutants designated as of primary or dual significance (see Section IX of this report) which are proposed for regulation under BAT. All pesticide process wastewaters are subject to the regulation of the priority pollutant parameters.

The first factor considered was discharge status. There are two priority pollutants, bis(2-chloroethyl) ether and 1,3-dichloropropene, proposed for regulation which have attained a zero discharge status for process wastewater only in processes in which it is the manufactured product. These pollutants are proposed to be excluded from regulation in all other processes due to lack of adequate monitoring data.

A second factor initially considered in defining priority pollutant parameters to be regulated under BAT was the status of regulation under BPT or 307(a) of the Act. There are nine priority pollutants previously regulated for direct discharge. Therefore, these nine priority pollutant pesticides do not require re-regulation for existing direct discharges; however, they do require regulation for indirect discharge (see Section XIV, PSES/PSNS) and new source direct discharges (see Section XIII, NSPS).

The third factor considered was analytical methods availability. EPA analytical methods for the remaining 23 priority pollutants of primary or dual significance have been proposed under Section 304(h) of the Act (44 FR 69464, 40 CFR 136) and are soon to be promulgated (see Section XXI, Appendix 8, Column 2). In addition, analytical methods for all 34 priority pollutants, which have been supplied by the industry, are available as part of the pesticides Administrative Record. Three priority pollutants (1,2-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene) are proposed for regulation only in those processes in which they are the manufactured products. They are proposed for exclusion from regulation in all other processes where they are expected to be controlled by regulation of the priority pollutant of primary significance, chlorobenzene.

Ambient Water Quality Criteria (WQC) for the protection of human health and aquatic life and additional pollutant-specific toxicity data are available for the all priority pollutants proposed for regulation and presented in Section IX of this report.

IDENTIFICATION OF BEST AVAILABLE TECHNOLOGY ECONOMICALLY ACHIEVABLE

This section addresses the derivation of BAT effluent limitations which includes identifying treatment technology options, selection of long-term averages, option selection based on economic and technical aspects of implementing the BAT regulation, and treatment variability. The selection of long-term averages and treatment variability are discussed in Section XV (Selection of Effluent Limitations and Pretreatment Standards).

Four levels of treatment were initially considered based on technical feasibility and performance data presented in Section VI. The design effluents of these three systems are presented. One level of treatment was selected as Best Available Technology, based on an evaluation of both the economic and technical aspects of implementing the regulation for each of the four levels.

BAT Technology Options for Manufacturing Facilities

Each of the recommended treatment units has been discussed in Section VI in terms of design and operating characteristics. These units have been combined into four levels of treatment options for Subcategories 1 through 10. The definitions of Levels 1, 2, 3, and 4 are presented graphically in Figures XII-1 through XII-10. The design effluents for the three levels of treatment (Levels 2, 3, and 4) are presented in Table XII-3. Design effluents are those levels of pollutants demonstrated or judged achievable for each recommended treatment technology, based on maximum raw waste loads found in the industry. The design effluent levels were used for cost analyses and options selection only and are not proposed effluent limitations. Four technology options and the rationale for each associated treatment level are given below:

Option 1/Level 1 for Direct Discharge--

This option provides for control of priority and nonconventional pesticide pollutants on the proper application and operation of the technologies that formed the basis of the BPT effluent limitations. The technologies on which the BPT regulation is based include pesticide removal by adsorption or hydrolysis followed by biological treatment. There would be no removal of additional pounds of toxic pollutants as well as no incremental cost for direct dischargers associated with this option.

Option 2/Level 2 for Direct Discharge--

This option provides combinations of treatment units to reduce groups of priority, conventional, and nonconventional pollutants detected or likely to be present to the design levels specified in Section VI. It

is recommended that Level 2 treatment (including biological oxidation) be applied to direct discharges into navigable waters. Level 2 treatment units, and the primary pollutant groups which they have been designed to remove, are as follows:

1. Steam Stripping--Volatile aromatics, halomethanes, haloethers, nitro substituted aromatics, chlorinated ethanes(ylenes), and ammonia removal.

2. Chemical Oxidation--Cyanide removal.

3. Metals Separation--Zinc, copper removal.

4. Activated carbon or resin adsorption--Pesticide phenols, nitrosamines, and dienes removal.

5. Hydrolysis--Pesticide removal only.

6. Biological Oxidation--Primary removal of BOD, COD, and TSS, incidental removal of priority pollutant groups and nonconventional pesticides as shown in Table XII-3.

Additional treatment/disposal options for which cost estimates have been prepared, but which are not necessary to meet Level 2 effluents, are as follows:

1. Incineration--Concentrated organic waste removal (for up to 1 percent of total wastewater flow, although generally not required).

2. Evaporation Ponds--As an alternative treatment for portions of total wastewater flow from 1,000 to 10,000 gpd, resulting in no discharge to navigable waters.

3. Contract Hauling--As an alternative treatment for portion of total wastewater flow from zero to 1,000 gpd, resulting in no discharge to navigable waters.

Implementation of this option would result in the removal of additional pounds of toxic pollutants (by priority pollutant/pollutant group) beyond Option 1, as follows:

Pollutant or Pollutant Group	Pollutant Removal (lbs/year)
Volatile Aromatics	140,000
Halomethanes	116,000
Cyanide	10,800
Phenols	54,600
Metals	18,500
Nitrosamines	475
Dienes	338
Chlorinated Ethanes	2,000

In addition, Option 2 would remove 440,000 lb of pesticide active ingredients per year beyond Option 1. There would be an incremental capital cost of $25,500,000 and an incremental annual treatment cost of $20,000,000 for direct dischargers associated with this option. Selection of this option is projected to result in the closure of two production lines and one plant.

Option 3/Level 3 for Direct Discharge--

Level 3 treatment for direct dischargers provides polishing after biological oxidation through the use of a dual media filter prior to discharge into navigable waters. The filter will remove biological solids, BOD, and COD, as well as any remaining insoluble matter such as metal particulates. An equally important function of filtration is the preparation of wastewater for subsequent tertiary treatment. Implementing this option would result in the removal of 192 lbs/year of priority pollutant metals beyond Option 2; it would not incrementally increase pollutant removal for any other priority pollutant group. There would be an incremental capital cost of $3,210,000 and an incremental annual treatment cost of $750,000 for direct dischargers associated with this option. There will be no additional closures beyond those projected in Option 2.

Option 4/Level 4 for Direct Discharge--

This option provides tertiary activated carbon adsorption for final removal of dissolved organics. In particular, compounds such as dienes, nitrosamines, and pesticides will be reduced. Implementation of this option would result in the incremental removal of additional pounds of toxic pollutants beyond Option 3, as follows:

Pollutant or Pollutant Group	Pollutant Removal (lbs/year)
Cyanides	11
Phenols	497
Chlorinated Ethanes	202
Dienes	44
Metals	95

In addition, Option 4 would remove 1,960 lbs of pesticide active ingredient pollutants per year beyond Option 3. There would be an incremental capital cost of $12,400,000 and an incremental annual treatment cost of $15,400,000 for direct dischargers associated with this option. There will be no additional closures beyond those projected in Option 2.

Economic Effects

A plant-by-plant treatment cost analysis was prepared in order to assess the effect on the industry of implementing each of the four technology

options. The results of this technical analysis were provided to the EPA pesticide economic contractor, so that the economic impact of the potential treatment costs on plant pesticide market value could be estimated.

All 117 manufacturing plants potentially affected by the Pesticide regulations were reviewed individually. For the BAT regulation, data from each of the 322 pesticides processes at these plants were evaluated and treatment units were costed for those priority pollutants and nonconventional pollutants detected or likely to exist in the wastewater at levels above the design levels selected in Table XII-3. Information on the process chemistry, raw waste load, treated waste load, type of disposal, current treatment practice, and flow were used in this review. The treatment units costed were selected according to the pollutants requiring removal as summarized in Table VI-22. The cost curves presented in Figures VIII-1 through VIII-22 were used in estimating costs based on actual wastewater flows.

Treatment cost estimates were based on the following criteria.

1. For those plants with effluent data exceeding design levels for priority pollutants and BPT levels for pesticides projected treatment was costed to bring the plant into compliance with the appropriate regulation.

2. For those plants without effluent data, it was assumed that pollutants germane to each process exist at effluent levels in excess of the design levels and appropriate treatment was costed accordingly.

3. Plant waste streams requiring similar treatment were assumed to use common treatment units.

4. Pesticide costs were proportioned based on pesticide flow. Where flow was unavailable, costs were proportioned based on production.

It should be noted that treatment cost estimates may in some cases be overestimated due to such factors as:

1. Treatment costs for activated carbon were based on the purchase of the activated carbon system and regeneration facilities. This is more expensive than the leasing of activated carbon systems which is prevalent in the industry.

2. Contract hauling has been costed to handle hazardous waste at $\$60/yd^3$. Disposal costs may be cheaper if wastes are determined to be nonhazardous.

Based on the above-mentioned analysis, plant costs were provided to the economic contractor. Those plants determined by the economic contractor to have treatment cost impacts greater than 4 percent of the pesticide

market value were reviewed in greater depth. At each of these plants annual treatment costs were reevaluated by basing the calculations on the actual daily production rather than on previously assumed full year production. Additionally, capital costs were revised to accommodate only the largest pesticide flow to be treated over the period of one year rather than the daily production of all manufactured pesticides as previously assumed. Treatment costs were estimated only for those priority pollutants and nonconventional pollutants to be regulated.

The results of this analysis are summarized below and in the following table. Of the 117 plants and 322 pesticide wastewater streams considered, it is anticipated that between 10 and 15 direct dischargers will require additional pollutant removal to reach the design effluent levels. This could affect between 34 and 35 pesticide wastewater streams from direct dischargers depending upon the recommended level of treatment selected for regulation.

	Economic Effect of Implementing Design Levels					
	Direct Discharge					
	Level 2		Level 3*		Level 4*	
Sub-category	Capital ($1000)	Annual ($1000)	Capital ($1000)	Annual ($1000)	Capital ($1000)	Annual ($1000)
1	3500	1680	263	52	718	451
2	7320	4880	1290	300	5010	6320
3	0	0	0	0	0	0
4	0	0	0	0	0	0
5	0	0	64	16	379	483
6	0	0	0	0	0	0
7	0	0	0	0	0	0
8	0	0	0	0	0	0
9	910	600	524	123	2290	2800
10	12400	11900	1070	254	4000	5390
11	0	0	0	0	0	0
12	0	0	0	0	0	0
13	0	0	0	0	0	0

* Level 3 cost is in addition to Level 2 cost. Level 4 cost is in addition to Level 2 and Level 3 costs.

The same treatment costs are summarized for all affected plants in the industry as follows:

	Priority Pollutant and Nonconventional Pesticide Removal		
	Direct Discharge		
	Level 2	Level 3	Level 4
No. of Plants Affected	13	11	10
No. of Pesticide Processes Affected	31	35	34
Capital Cost ($1000s)	24,200	3,210*	12,400*
Annual Cost ($1000s)	19,100	750*	15,400*

* Level 3 costs in addition to Level 2 costs. Level 4 costs in addition to Level 2 and Level 3 costs.

In order to demonstrate the portion of the total treatment cost estimate devoted strictly to nonconventional pesticide removal, the following table is presented.

	Nonconventional Pesticide Removal		
	Direct Discharge		
	Level 2	Level 3	Level 4
No. of Plants Affected	7	8	8
No. of Pesticide Processes Affected	19	32	32
Capital Cost ($1000s)	21,000	2,710*	11,700*
Annual Cost ($1000s)	15,700	647*	15,100*

* Level 3 costs in addition to Level 2 costs. Level 4 costs in addition to Level 2 and Level 3 costs.

Selection of Best Available Technology for Manufacturing Facilities

Based on the foregoing discussion of treatment options and economic effects, it was concluded that Option 2 with Level 2 treatment should be implemented for BAT. [An exception is that BAT for Subpart N (Subcategory 11) shall be equal to BPT, which is being proposed as no discharge of process wastewater.]

Direct discharge Level 2 treatment removes approximately 99 percent of the priority and nonconventional pesticide pollutants at an estimated capital cost of 24.2 million dollars. The Agency rejected Option 1 because the BPT technologies do not adequately provide for the removal of certain priority pollutant groups of concern, e.g., volatile aromatics, halomethanes, chlorinated ethanes, cyanide, and metals. The Agency rejected Option 3 because it is ineffective in removing priority pollutants. The Agency rejected Option 4 due to its extremely high cost.

Whereas, direct discharge Levels 2 and 3 remove approximately an additional 1 percent of all pollutants to be regulated at an estimated capital cost of 15.6 million dollars, the capital cost required per percent of pollutant removed is increasingly severe for Levels 2 and 3. Direct discharge Level 2 was estimated to require capital expenditures of over 4 percent market value at only 13 of the 117 plants evaluated.

BAT Regulatory Options for Select Metallo-Organic Pesticide Manufacturers

The metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products were not researched during the early development stages of these regulations. However, at that time, the current state-of-the-art was such that no discharge of process wastewater pollutants was being achieved through the application of recycle

technology. Therefore, existing direct discharge manufacturers of metallo-organic pesticides containing mercury, copper, cadmium, or arsenic were regulated at zero discharge during BPT. Current review of available information indicates that select metallo-organic manufacturers maintain zero discharge. Additional technical and economic data have been collected for this portion of the industry subsequent to promulgation of the BPT regulation. EPA has therefore selected the BPT technology of total recycle or reuse, evaporation, or contract hauling of process wastewater as the basis for proposed BAT for metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products. Implementation of this option will establish regulatory consistency with the BPT effluent limitation and will satisfy the requirements of the consent decree. Annual and capital costs for this technology level will vary depending on the treatment used as shown in Table XII-4. For example, if solar evaporation is used, capital costs for installation of this technology in a 500-GPD flow will range from $42,000 to $160,000. Annual costs will range from $10,500 to $28,000.

BAT Regulatory Options for Formulator/Packagers

Direct discharge formulator/packagers were regulated at zero discharge under BPT. These data, along with current information, show that approximately 90 percent of all formulator/packagers in that data base do not generate process wastewater. The remaining plants in the data base generate low volume, highly concentrated wastewater from such controls as washout of reaction vessels of air emissions scrubbers. These plants typically evaporate or contract haul these wastes to meet the current BPT zero discharge limitation. Additional technical and economic data have been collected for this portion of the industry subsequent to promulgation of the BPT regulation. The Agency believes that formulator/packagers conduct the same types of operations regardless of mode of discharge. The Agency solicits any comments from the industry pertaining to this matter. Accordingly, the Agency is basing BAT limitations for direct discharger formulator/packagers on the BPT technology of total evaporation or contract hauling. Implementation of this option will establish regulatory consistency with the BPT effluent limitations for direct dischargers and will satisfy the requirements of the consent decree. Annual and capital costs for implementation of this technology level shown in Table XII-5 will be the same as the costs for the metallo-organic portion of the industry.

Selection of Long-Term Averages

The long-term average effluents for direct dischargers are defined in Section XV for manufacturers, including metallo-organic manufacturers of mercury, copper, cadmium, and arsenic-based products, and formulator/packagers.

Effluents Achieved--

The effluents currently achieved by direct dischargers are summarized in Section XV.

Effluents Achievable--

The effluents achievable by direct dischargers are summarized in Section XV. The purpose of this evaluation is to compare existing treatment at each plant to treatment recommended for BAT, and to predict effluents achievable through the application of BAT, if necessary.

Treatment Variability

Effluent variability factors for direct dischargers are defined in Section XV. Daily and monthly factors are applied to long-term averages in order to derive effluent limitations.

Effluent Limitations

Effluent limitations guidelines for direct dischargers are presented in Tables II-7 through II-19.

Table XII-1. Nonconventional Pesticide Pollutant Regulatory Status

Pesticides to be Regulated for the Nonconventional Pesticide Parameter	No Wastewater Discharge	Not Previously Regulated*
Alachlor	--	X
Alkylamine hydrochloride	X	N/A
Ametryne	--	X
Amobam	X	N/A
AOP	--	X
Atrazine	--	X
Barban	X	--
BBTAC	X	N/A
Benfluralin	--	X
Benomyl	--	X
Bentazon	--	X
Biphenyl	X[1]	N/A
Bolstar	--	X
Bromacil	--	X
Busan 40	--	X
Busan 85	--	X
Butachlor	--	X
Carbam-S	--	X
Carbendazim	--	X
Carbofuran	--	X
Carbophenothion	--	X
Chlorobenzilate	--	X
Chloropicrin	X[2]	N/A
Chlorpyrifos	--	X
Chlorpyrifos methyl	--	X
Coumaphos	--	X
Cyanazine	--	X

1 = For Plant 1 only.
2 = For Plants 2, 3, and 4 only.
N/A = Not applicable.
* = For which analytical methods are available.
X = Basis for proposed regulation.
-- = No basis for proposed regulation.

Table XII-1. Nonconventional Pesticide Pollutant Regulatory Status (Continued, Page 2 of 5)

Pesticides to be Regulated for the Nonconventional Pesticide Parameter	No Wastewater Discharge	Not Previously Regulated*
2,4-D isobutyl ester	--	X
2,4-D isooctyl ester	X[1]	X[2]
2,4-D salt	X	N/A
2,4-DB	--	X
2,4-DB isobutyl ester	--	X
2,4-DB isooctyl ester	--	X
DBCP	--	X
D-D	X	N/A
Deet	--	X
Demeton	--	X
Dichlofenthion	--	X
Dichlorophen salt	X	N/A
Dichlorvos	--	X
Dinoseb	--	X
Dioxathion	--	X
Dowicil 75	X	N/A
Ethalfluralin	--	X
Ethion	--	X
Ethoprop	X	N/A
Etridiazole	--	X
Fensulfothion	--	X
Fenthion	--	X

[1] = For Plant 5 only.
[2] = For Plant 6 only.
N/A = Not applicable.
* = For which analytical methods are available.
X = Basis for proposed regulation.
-- = No basis for proposed regulation.

Table XII-1. Nonconventional Pesticide Pollutant Regulatory Status (Continued, Page 3 of 5)

Pesticides to be Regulated for the Nonconventional Pesticide Parameter	No Wastewater Discharge	Not Previously Regulated*
Ferbam	—	X
Fluometuron	—	X
Fluoroacetamide	X	N/A
Glyodin	X	N/A
Glyphosate	—	X
Hexazinone	—	X
HPTMS	X	N/A
Isopropalin	—	X
KN Methyl	—	X
Mancozeb	—	X
Maneb	—	X
Mephosfolan	—	X
Merphos	X	N/A
Metasol J-26	X	N/A
Metham	—	X
Methomyl	—	X
Metribuzin	—	X
Mevinphos	—	X
Nabam	—	X
Naled	—	X

N/A = Not applicable.
* = For which analytical methods are available.
X = Basis for proposed regulation.
-- = No basis for proposed regulation.

Table XII-1. Nonconventional Pesticide Pollutant Regulatory Status (Continued, Page 4 of 5)

Pesticides to be Regulated for the Nonconventional Pesticide Parameter	No Wastewater Discharge	Not Previously Regulated*
Niacide	--	X
Oxamyl	--	X
PCP salt	--	X
Phorate	--	X
Profluralin	--	X
Prometon	--	X
Prometryn	--	X
Propachlor	--	X
Propazine	--	X
Pyrethrin	X	N/A
Ronnel	--	X
Silvex isooctyl ester	X	N/A
Silvex salt	X	N/A
Simazine	--	X
Simetryne	--	X
Sodium monofluoroacetate	X[1]	N/A
Stirofos	--	X
Terbacil	--	X
Terbufos	--	X
Terbuthylazine	--	X
Terbutryn	--	X

[1] = For Plant 7 only.
N/A = Not applicable.
* = For which analytical methods are available.
X = Basis for proposed regulation.
-- = No basis for proposed regulation.

Table XII-1. Nonconventional Pesticide Pollutant Regulatory Status (Continued, Page 5 of 5)

Pesticides to be Regulated for the Nonconventional Pesticide Parameter	No Wastewater Discharge	Not Previously Regulated*
Triadimefon	--	X
Tributyltin benzoate	X	N/A
Tributyltin oxide	X[1]	N/A
Trichloronate	--	X
Tricyclazole	--	X
Vancide 51Z	X	N/A
Vancide 51Z dispersion	X	N/A
Vancide TH	X	N/A
ZAC	--	X
Zineb	--	X
Ziram	X[2]	X[3]
TOTAL	27	76

[1] = For Plant 8 only.
[2] = For Plant 9 only.
[3] = For Plants 10 and 11 only.
N/A = Not applicable.
* = For which analytical methods are available.
X = Basis for proposed regulation.
-- = No basis for proposed regulation.

Table XII-2. Priority Pollutant Regulatory Status

Priority Pollutants to be Regulated	No Wastewater Discharge	Not Previously Regulated
Volatile Aromatics		
Benzene	--	X
Chlorobenzene	--	X
Toluene	--	X
1,2-Dichlorobenzene*	--	X
1,4-Dichlorobenzene*	--	X
1,2,4-Trichlorobenzene*	--	X
Halomethanes		
Carbon tetrachloride	--	X
Chloroform	--	X
Methyl bromide	--	X
Methyl chloride	--	X
Methylene chloride	--	X
Cyanide		
Cyanide	--	X
Haloethers		
Bis(2-chloroethyl) ether†	X	N/A
Phenols		
2,4-Dichlorophenol	--	X
2,4-Dinitrophenol	--	X
4-Nitrophenol	--	X
Pentachlorophenol	--	X
Phenol	--	X

* = Proposed for regulation only in those processes in which it is the manufactured product; proposed for exclusion from regulation in all other processes where it is expected to be controlled by regulation of chlorobenzene.

† = Proposed for regulation only in those processes in which it is the manufactured product; proposed to be excluded from regulation in all other processes due to lack of adequate monitoring data.

X = Basis for proposed regulation.

-- = No basis for proposed regulation.

N/A = Not applicable.

Table XII-2. Priority Pollutant Regulatory Status
(Continued, Page 2 of 2)

Priority Pollutants to be Regulated	No Wastewater Discharge	Not Previously Regulated
Metals		
Copper	--	X
Zinc	--	X
Chlorinated Ethanes and Ethylenes		
1,2-Dichloroethane	--	X
Tetrachloroethylene	--	X
Nitrosamines		
N-nitrosodi-n-propylamine	--	X
Dichloropropane and Dichloropropene		
1,3-Dichloropropene†	X	N/A
Dienes		
Hexachlorocyclopentadiene	--	X
TOTAL	2	23

* = Proposed for regulation only in those processes in which it is the manufactured product; proposed for exclusion from regulation in all other processes where it is expected to be controlled by regulation of chlorobenzene.

† = Proposed for regulation only in those processes in which it is the manufactured product; proposed to be excluded from regulation in all other processes due to lack of adequate monitoring data.

N/A = Not applicable.

X = Basis for proposed regulation.

-- = No basis for proposed regulation.

Table XII-3. Direct Discharge Design Effluent Levels*

Pollutant Group†	LEVEL 2** Direct Discharger (mg/l)	LEVEL 2** Direct Discharger (lbs/1,000 lbs)	LEVEL 3†† Direct Discharger (mg/l)	LEVEL 3†† Direct Discharger (lbs/1,000 lbs)	LEVEL 4° Direct Discharger (mg/l)	LEVEL 4° Direct Discharger (lbs/1,000 lbs)
Volatile Aromatics	<0.01	<0.00037	<0.01	<0.00037	<0.01	<0.00037
Halomethanes	<0.01	<0.00037	<0.01	<0.00037	<0.01	<0.00037
Cyanides	0.02	0.00075	0.02	0.00075	<0.01	<0.00037
Haloethers	0.05	0.0019	0.05	0.0019	<0.01	<0.00037
Phenols	0.1	0.0037	0.1	0.0037	<0.01	<0.00037
Polynuclear Aromatics	0.1	0.0037	0.1	0.0037	<0.01	<0.00037
Metals	0.25	0.0094	0.15	0.0056	<0.1	<0.0037
Chlorinated Ethanes (ylenes)	0.1	0.0037	0.1	0.0037	<0.01	<0.00037
Nitrosamines	0.001	0.000037	0.001	0.000037	<0.001	<0.000037
Dienes	0.023	0.00086	0.023	0.00086	<0.01	<0.00037
Pesticides	0.5	0.019	0.5	0.019	<0.01	<0.00037
BOD	30	1.13	20	0.75	10	0.37
COD	586	22.0	470	17.6	235	8.82
TSS	35	1.31	10	0.37	5	0.19

* Long-term average effluents demonstrated or judged achievable (as presented in Section VI) from maximum design raw waste load levels (as presented in Section V). Design effluents used for cost analyses only.

† Pollutant groups excluded are not known to be present at or above the level of interest.

** Level 2 for direct dischargers includes pretreatment by steam stripping, chemical oxidation, metals separation, adsorption by resin or carbon, or hydrolysis as appropriate plus biological oxidation.

†† Level 3 includes direct discharge Level 2 plus dual media filtration.

° Level 4 includes Level 3 plus granular activated carbon.

N/A = Not applicable.

lbs/1,000 lbs = 4,500 gal/1,000 lbs x 8.34 x mg/l (where 4,500 gal/1,000 lbs is design flow for industry).

Table XII-4. Option 1 BAT Costs for Direct Discharge Metallo-Organic Manufacturers

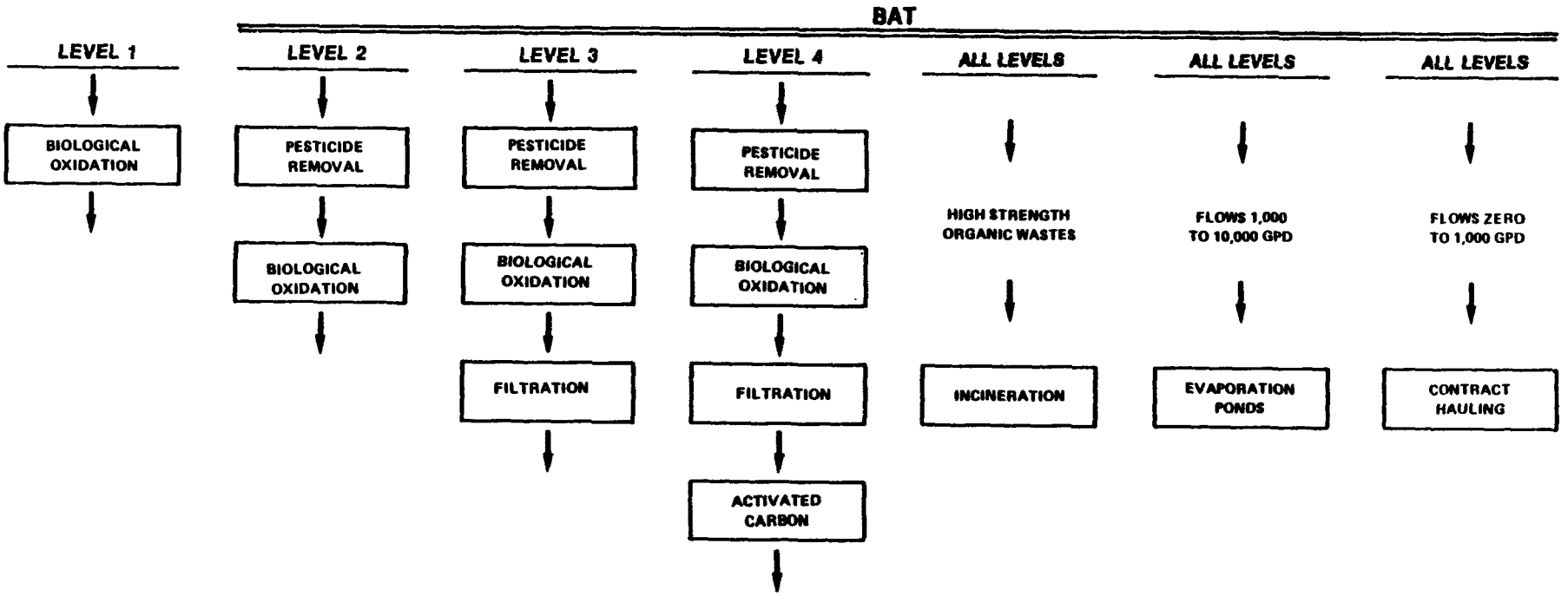
	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE - Net evaporation.
psi = Pounds per square inch.

Table XII-5. Option 1 BAT Costs for Direct Discharge Formulator/Packagers

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

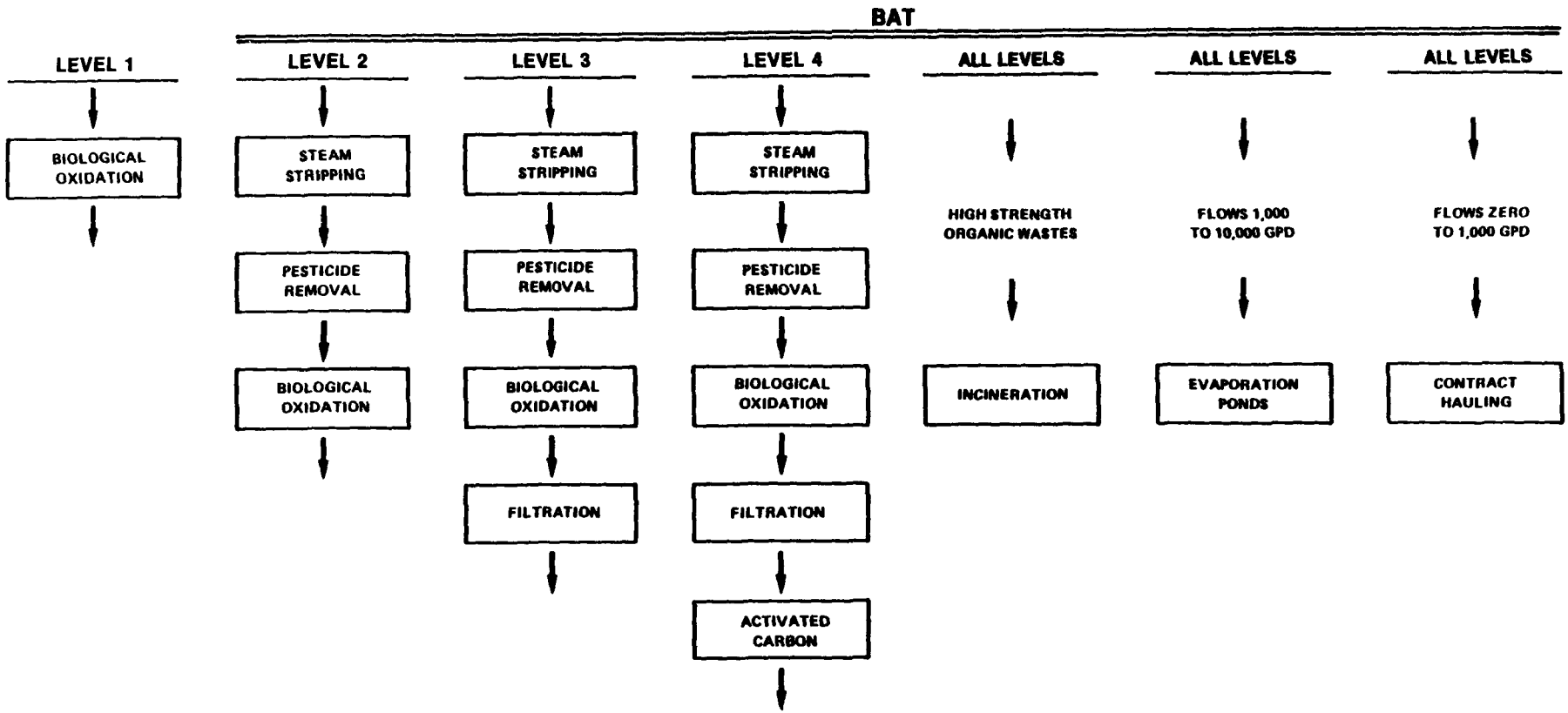
NE = Net evaporation.
psi = Pounds per square inch.



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

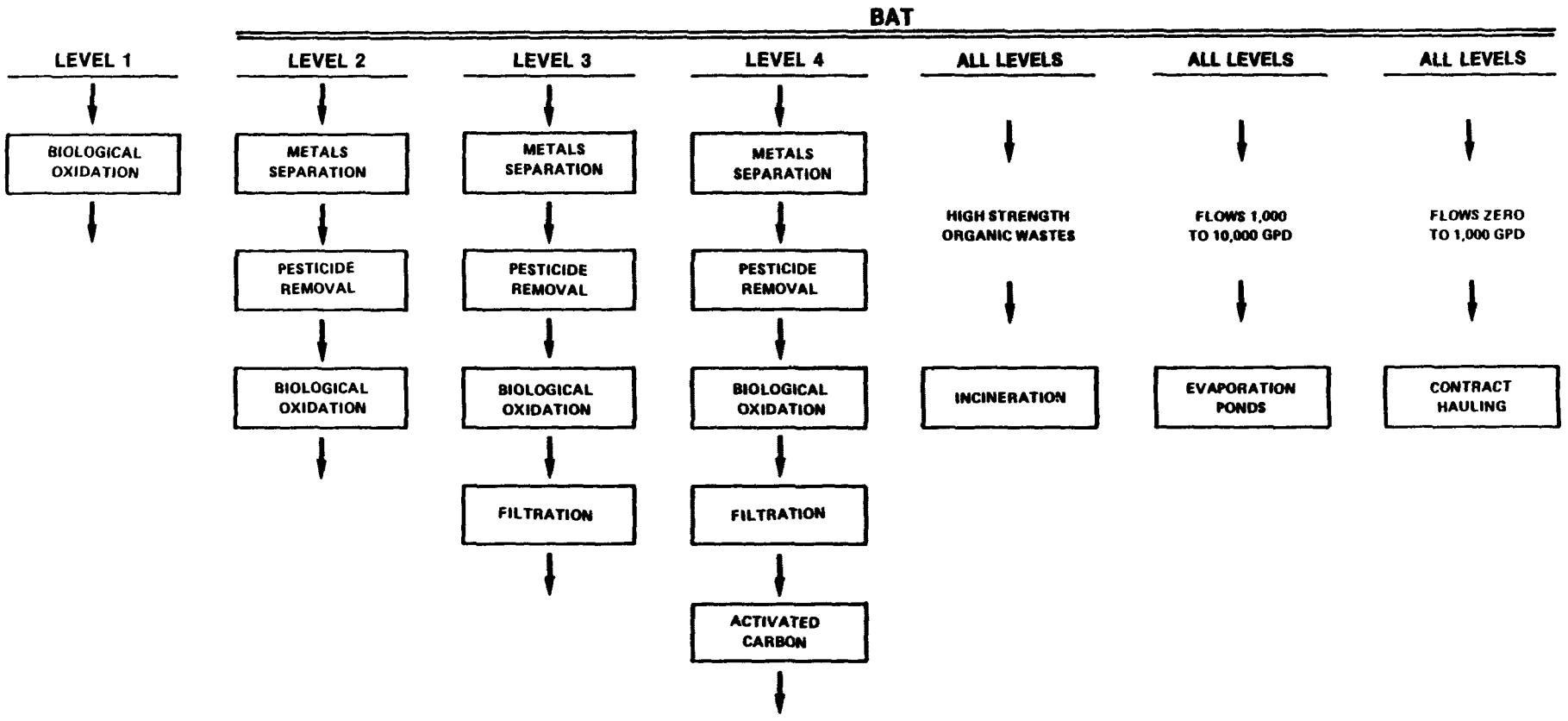
Figure XII-1 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 1



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

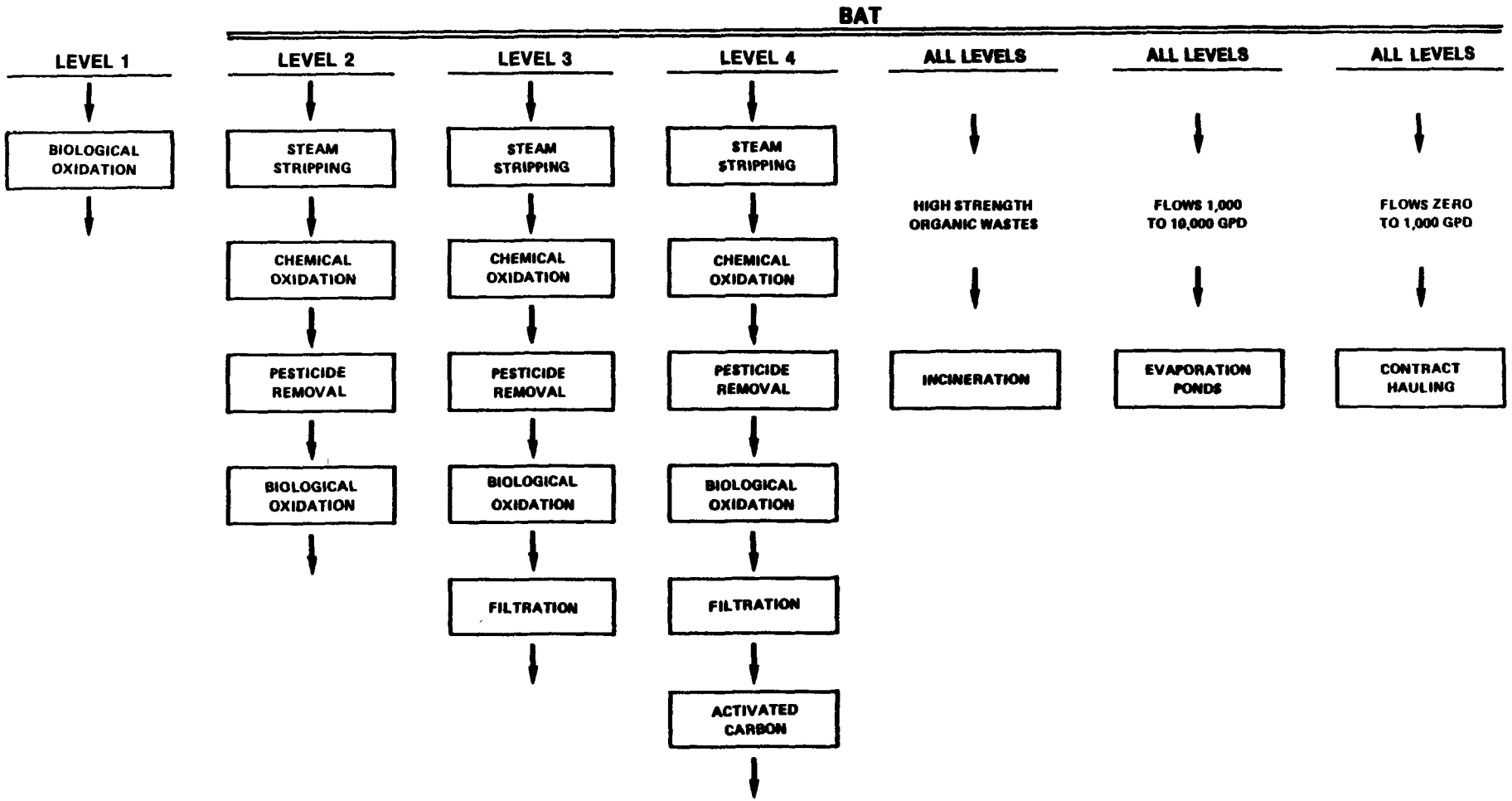
Figure XII-2 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 2



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED *CARBON OR FILTRATION AND RESIN ADSORPTION*

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

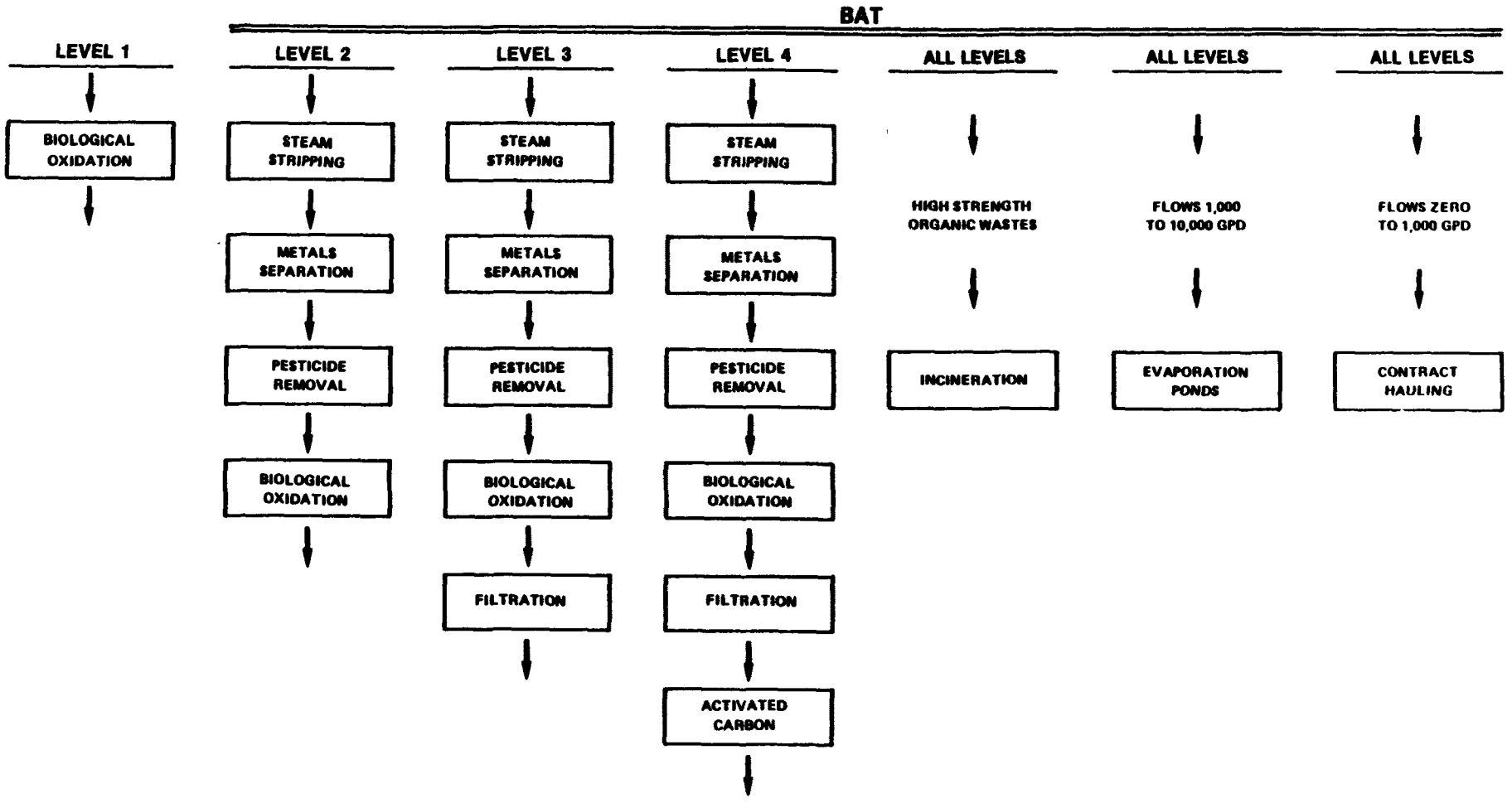
Figure XII-3 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 3



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

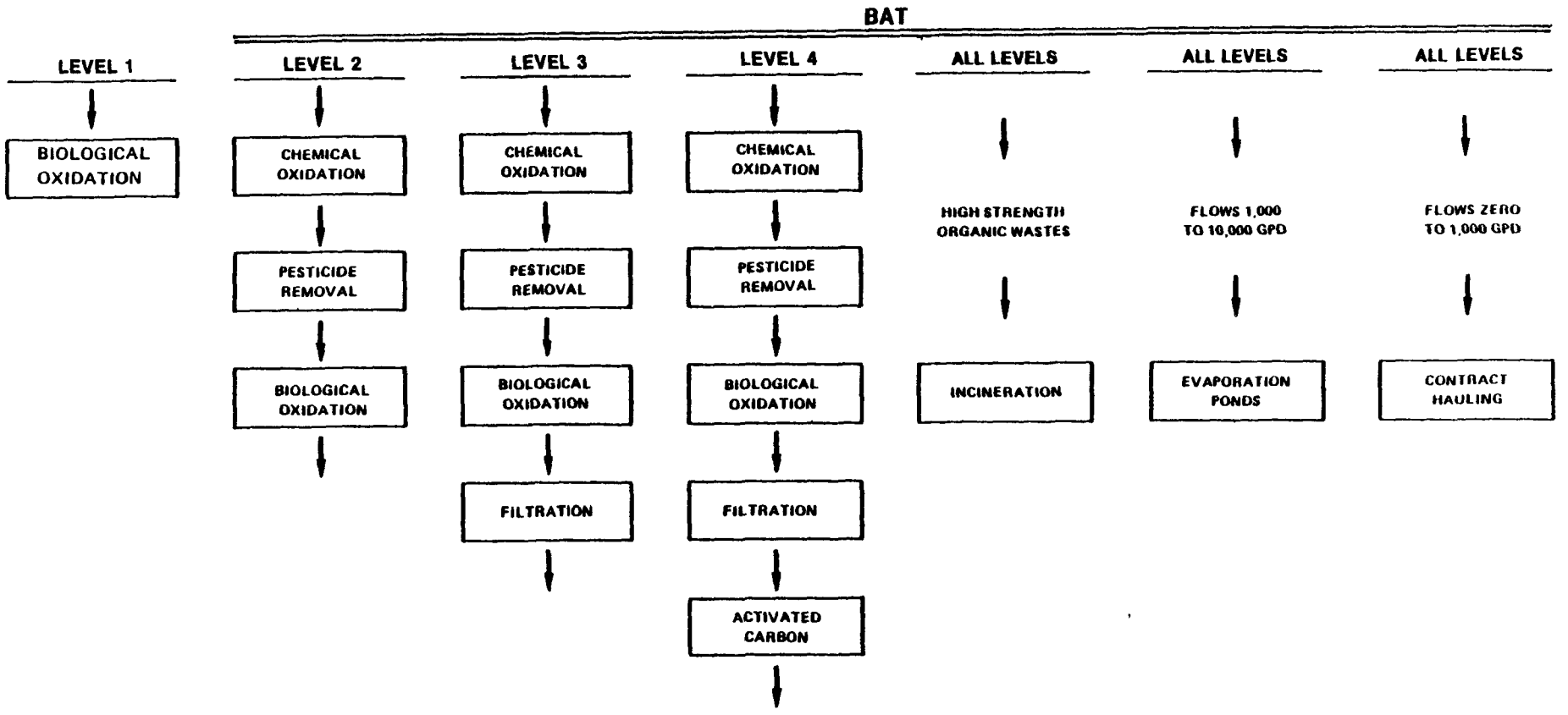
Figure XII-4 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 4



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

Figure XII-5 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 5



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

Figure XII-6 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 6

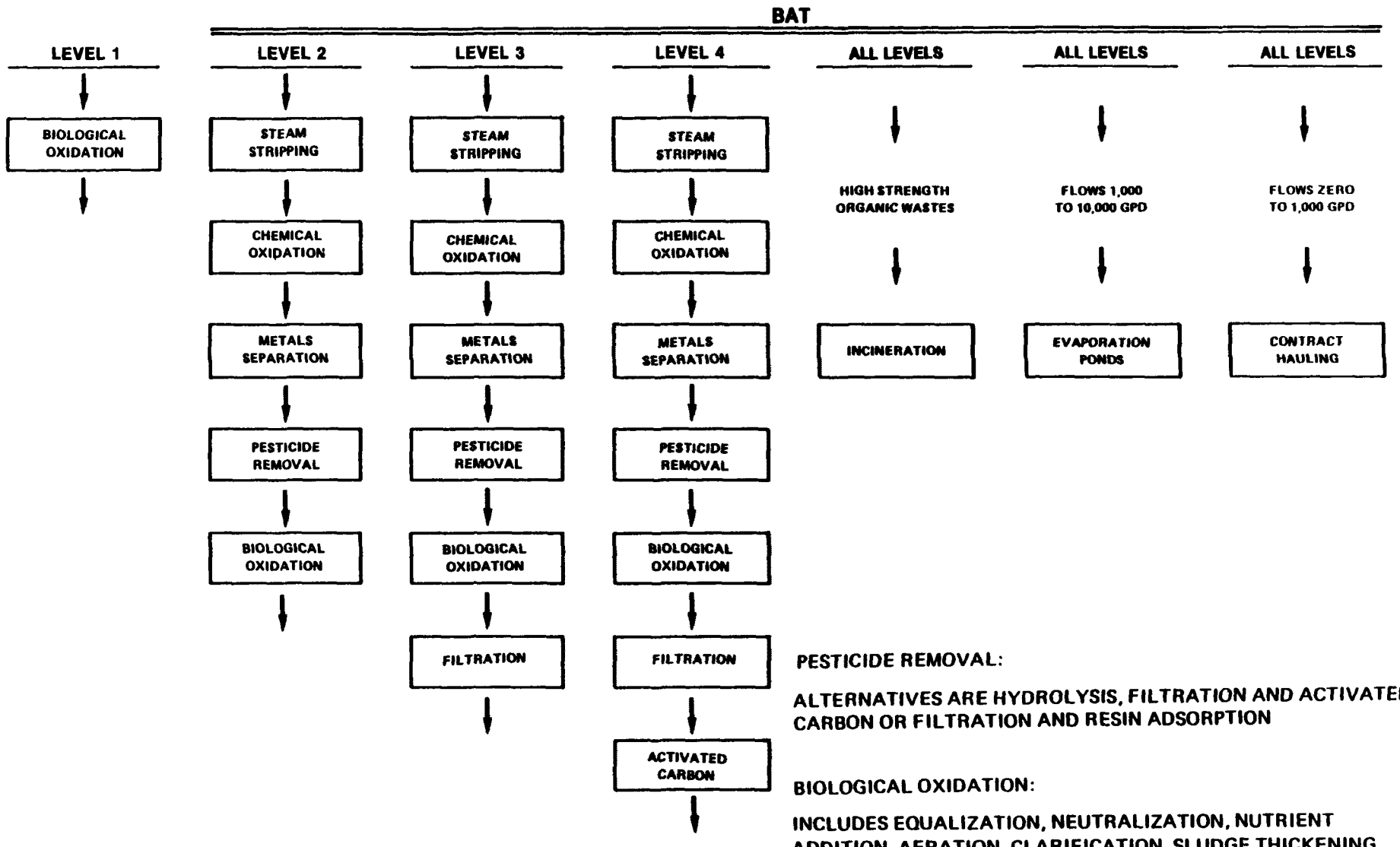
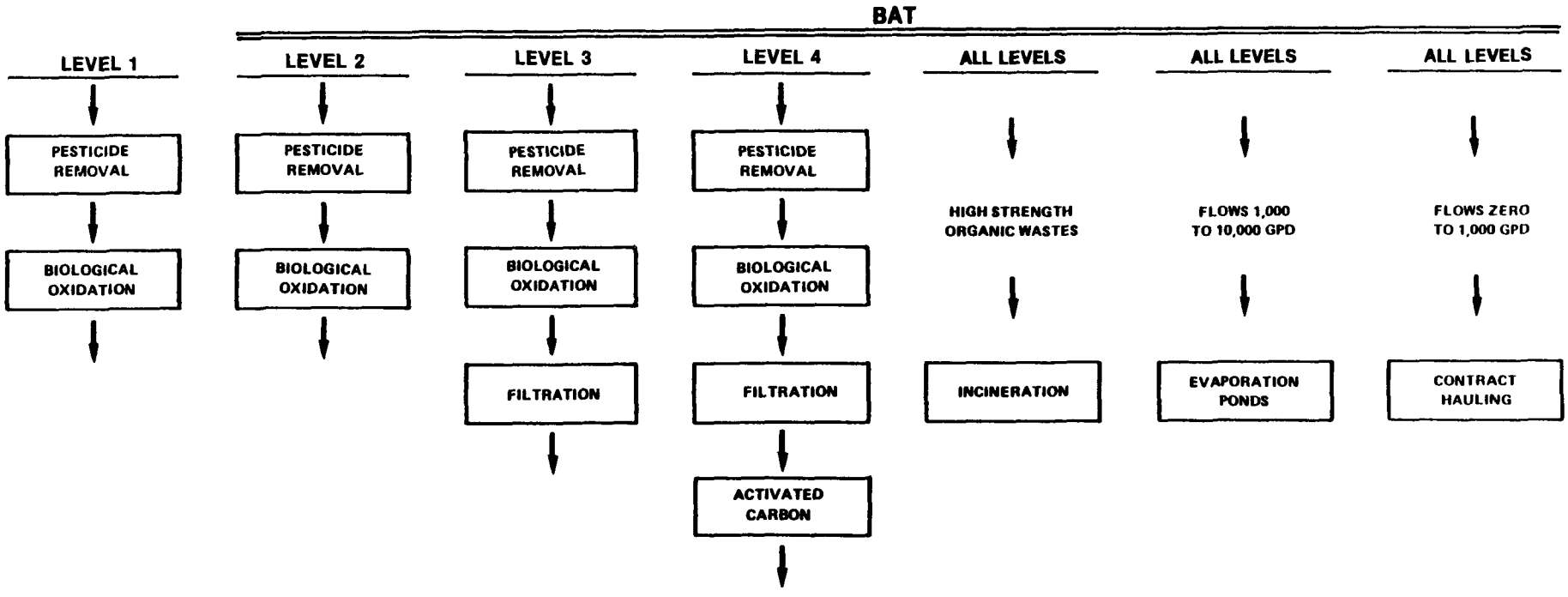


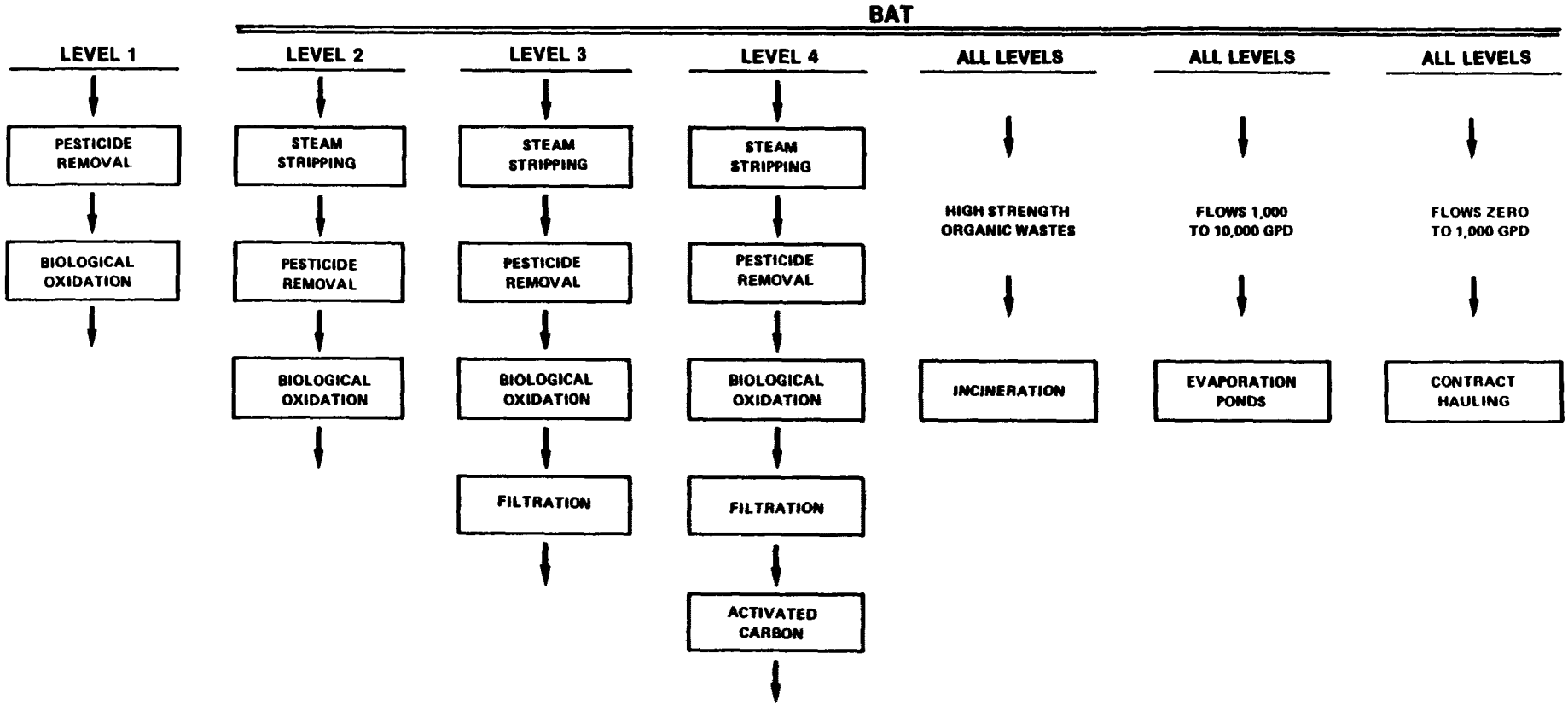
Figure XII-7 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 7



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

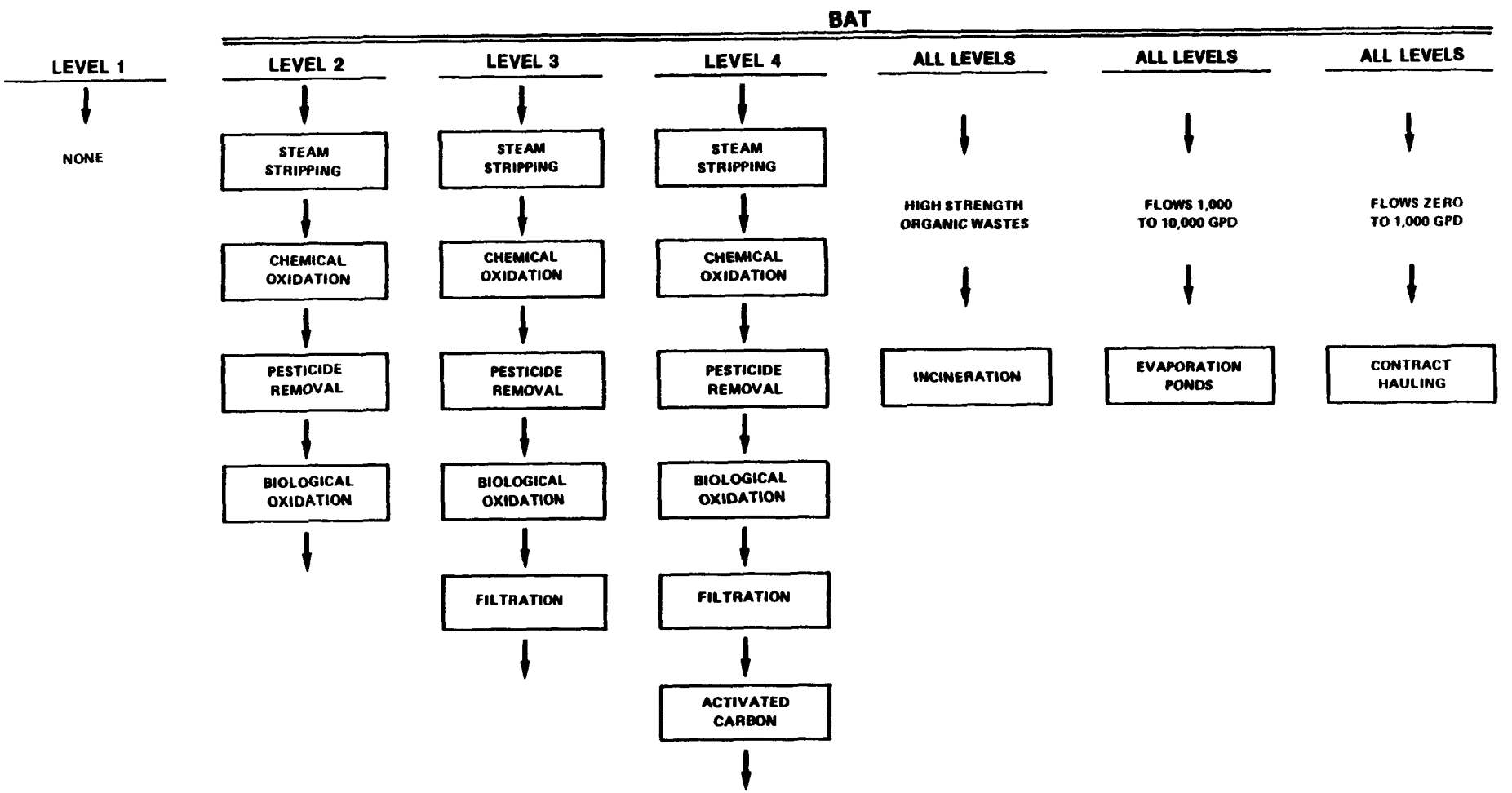
Figure XII-8 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 8



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

Figure XII-9 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 9



PESTICIDE REMOVAL: ALTERNATIVES ARE HYDROLYSIS, FILTRATION AND ACTIVATED CARBON OR FILTRATION AND RESIN ADSORPTION

BIOLOGICAL OXIDATION: INCLUDES EQUALIZATION, NEUTRALIZATION, NUTRIENT ADDITION, AERATION, CLARIFICATION, SLUDGE THICKENING, AEROBIC DIGESTION, AND VACUUM FILTRATION

Figure XII-10 RECOMMENDED LEVELS OF TREATMENT SUBCATEGORY 10

SECTION XIII

NEW SOURCE PERFORMANCE STANDARDS

The basis for new source performance standards (NSPS) under Section 306 of the Act is the best available demonstrated technology (BADT). New direct discharge manufacturers, formulator/packagers, and metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products have the opportunity to design the best and most efficient pesticide processes and wastewater treatment technologies. Therefore, Congress directed EPA to consider the best demonstrated process changes, in-plant controls, and end-of-pipe treatment technologies which reduce pollution to the maximum extent feasible. A major difference between NSPS and BAT is that the Act does not require evaluation of NSPS in light of a cost-effectiveness test.

It is proposed that NSPS for pesticide manufacturers include 101 nonconventional pesticide and 25 priority pollutants proposed for regulation under BAT, and conventional pollutants and COD proposed for regulation under expanded BPT. In addition, 36 nonconventional pesticide and 9 priority pollutant pesticides previously regulated for direct discharge under BPT are also proposed for regulation under NSPS. The effluent limitations guidelines for pesticide manufacturer NSPS are listed in Tables II-20 through II-30.

It is also proposed that NSPS for pesticide formulator/packagers and select metallo-organic manufacturers be proposed as zero discharge of all process wastewater. The proposed NSPS effluent limitation for select metallo-organic manufacturers and formulator/packagers is listed in Tables II-31 and II-32, respectively.

POLLUTANT PARAMETERS PROPOSED FOR REGULATION

Nonconventional pesticides proposed for regulation under NSPS include those listed under BAT in Table XII-1. In addition, 36 nonconventional pesticide pollutants listed in Table XIII-1, which were previously regulated in BPT for direct discharge, are also proposed for NSPS regulation.

Priority pollutants proposed for regulation under NSPS include those listed under BAT in Table XII-2. In addition, 9 priority pollutant pesticides listed in Table XIII-2, which were previously regulated in BPT for direct discharge, are also proposed for NSPS regulation for the priority pollutant parameter.

It is proposed that NSPS equal expanded BPT for the regulation of the conventional pollutants BOD, TSS, pH, and COD.

IDENTIFICATION OF NEW SOURCE PERFORMANCE STANDARDS TECHNOLOGY

Data from existing pesticide manufacturing plants were used to define a model direct discharger for each subcategory. Average subcategory production and discharge flow rates were used to define the model plant. The derivation of NSPS includes identifying technology options, option selection based on economic and technical aspects of implementing the regulation, and determining long-term averages and variability. The selection of long-term averages and treatment variability are discussed in Section XV (Selection of Effluent Limitations and Pretreatment Standards).

NSPS Technology Options for Manufacturing Facilities

Three technology options have been developed for new source performance standards for pesticide manufacturers. The options are the same as Options 2, 3, and 4 listed in Section XII under BAT and are also summarized in the following paragraphs.

Option 1--

Option 1 bases effluent limitations for control of priority, nonconventional, and conventional pollutants on the selected BAT Option 2 technologies of pesticide removal followed by biological treatment, in addition to steam stripping, chemical oxidation, and/or metals separation, as required. Implementation of this option would achieve significant removal of the pollutants of concern expected to be generated by a representative new source. The pollutant removal percentages that would be achieved by a representative new source are as follows:

Pollutant or Pollutant Group	Pollutant Removal (lbs/year)
Volatile Aromatics	3,330
Halomethanes	2,760
Cyanide	257
Phenols	1,300
Metals	440
Chlorinated Ethanes (ethylenes)	48
Nitrosamines	11
Dienes	8
Pesticides	
Priority Pollutant	759
Nonconventional	10,500
BOD	209,000
COD	478,000
TSS	33,600

Capital costs for installation of this technology level will range from zero dollars (no direct discharger in a subcategory) to 8 million dollars (maximum treatment) per plant. Annual operation and maintenance

costs will range from 0.042 to 4.6 million dollars per plant. These costs do not represent incremental costs from BAT.

Option 2--

Option 2 bases effluent limitations for control of priority, nonconventional, and conventional pollutants on the Option 1 technologies followed by multi-media filtration. Implementation of this option would result in additional removal of specific pollutants beyond Option 1 by a representative new source, as follows:

Pollutant or Pollutant Group	Pollutant Removal (lbs/year)
Metals	4
BOD	1,430
COD	17,100
TSS	150,000

Capital costs for installation of this technology level will range from zero to $250,000 per plant. Annual operation and maintenance costs will range from zero to $57,000 per plant.

Option 3--

Option 3 bases effluent limitations for control of priority, nonconventional, and conventional pollutants on the Option 2 technologies followed by tertiary activated carbon treatment. Implementation of this option would result in additional removal of specific pollutants beyond Option 2 by a representative new source, as follows:

Pollutant Or Pollutant Group	Pollutant Removal (lbs/year)
Cyanide	0.2
Phenols	12
Metals	2
Chlorinated Ethanes (Ethylenes)	5
Dienes	0.1
Pesticides	
Priority Pollutant	4
Nonconventional	47
BOD	1,430
COD	34,300
TSS	714

Capital cost for installation of this technology level will range from zero to $780,000 per plant. Annual operation and maintenance costs will range from zero to $950,000 per plant.

Selection of New Source Performance Standards Technology for Manufacturing Facilities

Option 1 treatment technology (physical/chemical and biological treatment) is recommended for control of priority, nonconventional, and conventional pollutants at new source pesticide plants. An exception is that NSPS for Subpart N (Subcategory 11) shall be equal to BPT, which is being proposed as no discharge of process wastewater.

Option 1 ensures that the discharge of 34 priority pollutants, 137 nonconventional pollutant pesticides, 3 conventional pollutants, and COD will be adequately controlled without resulting in an adverse economic impact on the industry. These proposed NSPS would not result in any economic barriers to industry entry. Option 2 was rejected because it is ineffective in removing priority pollutants and the majority of nonconventional pollutant pesticides. The Agency rejected Option 3 due to its extremely high cost.

NSPS Regulatory Options for Select Metallo-Organic Manufacturers

New metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products have the opportunity to incorporate the best available pesticide processes and wastewater treatment facilities. Existing manufacturers of these pesticides were required to achieve zero discharge of process wastewater under existing BPT.

EPA has selected the BPT technology of total recycle and reuse, evaporation, or contract hauling of all process wastewater as the basis for NSPS for new select metallo-organic pesticide manufacturers. The Agency believes that the processes used to manufacture pesticides in this subcategory at new sources will be identical or comparable to those used by facilities which achieve the BPT limitations. Selection of this technology level ensures the use of the most efficient wastewater control technologies at new sources. Since the NSPS are identical to standards for existing sources, there will be no barriers to entry by new sources. Capital costs for installation of this technology level will range from $16,400 for spray evaporation to $160,000 for solar evaporation per plant for an average flow of 500 GPD. Corresponding annual operation and maintenance costs will range from $10,500 for spray evaporation to $28,000 for solar evaporation per plant. There are no capital costs associated with contract hauling.

NSPS Regulatory Options for Formulator/Packagers

At new formulating/packaging facilities, the opportunity also exists to design the best and most efficient pesticide processes and wastewater treatment facilities such that reductions in the use of and/or discharge of both water and toxic pollutants will be maximized.

The BPT effluent limitation currently being applied to existing formulating/packaging facilities is zero discharge of process wastewater.

EPA has selected the BPT technology of total evaporation or contract hauling of all process wastewater as the basis for NSPS effluent limitations for new formulating/packaging facilities. The Agency believes that the volume and nature of pollutants to be generated at new sources are comparable to those generated at existing sources because there are only three basic types of formulations operations: dry, solvent, and water based with vessel wash out being the major source of pollutants. Selection of this technology level ensures the use of the most efficient pesticide formulating/packaging processes and wastewater treatment technologies at new sources. Since the NSPS are identical to the standards for existing sources, there will be no barriers to entry by new sources. Capital costs for installation of this technology level will range from $16,400 for spray evaporation to $160,000 for solar evaporation per plant, for an average flow of 500 GPD. Corresponding annual operation and maintenance costs will range from $10,500 for spray evaporation to $28,000 for solar evaporation per plant. There are no capital costs associated with contract hauling.

Selection of Long-Term Averages

The long-term average effluents for direct dischargers are defined in Section XV for manufacturers, including metallo-organic manufacturers of mercury, copper, cadmium, and arsenic-based products, and formulator/packagers.

Treatment Variability

Effluent variability factors for direct dischargers are defined in Section XV. Daily and monthly factors are applied to long-term averages in order to derive effluent limitations.

Effluent Limitations

NSPS effluent limitations guidelines for direct dischargers are presented in Tables II-20 through II-32.

Table XIII-1. Nonconventional Pesticide Pollutants to be Regulated Only by NSPS*

Aminocarb	Methiocarb
Azinphos methyl	Methoxychlor
Captan	Mexacarbate
Carbaryl	Mirex
Chlorpropham	Monuron
2,4-D	Monuron-TCA
DCNA	Neburon
Demeton-o	Parathion ethyl
Demeton-s	Parathion methyl
Diazinon	PCNB
Dicamba	Perthane
Dicofol	Propham
Disulfoton	Propoxur
Diuron	Siduron
Fenuron	Silvex
Fenuron-TCA	SWEP
Linuron	2,4,5-T
Malathion	Trifluralin

* Additional nonconventional pesticide pollutants proposed for regulation under NSPS include pollutants to be regulated under BAT (see Table XII-1).

Table XIII-2. Priority Pollutants to be Regulated Only by NSPS*

BHC-alpha
BHC-beta
BHC-delta
Endosulfan-alpha
Endosulfan-beta
Endrin
Heptachlor
Lindane (BHC-gamma)
Toxaphene

* Additional priority pollutants proposed for regulation under NSPS include pollutants to be regulated under BAT (see Table XII-2).

Table XIII-3. Option 1 NSPS Costs for Manufacturers

Subcategory	Cost ($1,000s)*			
	Capital		Annual	
	High	Low	High	Low
1	2,200	1,300	800	410
2	2,500	1,500	1,000	530
3	8,000	3,300	4,600	1,300
4	2,700	1,700	1,300	800
5	4,200	2,300	2,300	900
6	0	0	100	42
7	2,200	1,600	1,100	650
8	2,800	1,600	1,100	500
9	3,200	1,800	1,300	680
10	5,200	2,800	2,600	1,500
11†	0	0	0	0

* High and low costs reflect differences in degree of treatability or differences in recoveries obtainable.

† Proposed for regulation at zero discharge.

Table XIII-4. Option 1 NSPS Costs for Direct Discharge Metallo-Organic Manufacturers

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE = Net Evaporation.
psi = pounds per square inch.

Table XIII-5. Option 1 NSPS Costs for Direct Discharge Formulator/Packagers

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE = Net Evaporation.
psi = pounds per square inch.

SECTION XIV

PRETREATMENT STANDARDS

The effluent standards that must be achieved by new and existing sources in the Pesticide Chemicals Industry that discharge into a POTW are termed pretreatment standards. Sections 307(b) and (c) of the Act require EPA to promulgate pretreatment standards for existing sources (PSES) and new sources (PSNS) to prevent the discharge of pollutants which pass through, interfere with, or are otherwise incompatible with the operation of POTWs. The 1977 amendments to the Act also require pretreatment for pollutants, such as heavy metals, that limit POTW sludge management alternatives, including the beneficial use of sludges on agricultural lands.

The priority pollutant and nonconventional pesticide pollutant parameters to be regulated under PSES and PSNS are equivalent to those proposed for regulation under NSPS. These pollutants were proposed for regulation based on the same rationale provided under NSPS, Section XIII. The PSES and PSNS regulations will cover indirect discharge pesticide manufacturers, formulator/packagers, and metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products.

POLLUTANT PARAMETERS PROPOSED FOR REGULATION UNDER PSES AND PSNS

The nonconventional pesticide pollutants proposed for regulation under PSES and PSNS include 101 pollutants listed under BAT with the addition of 36 nonconventional pesticides, which were previously regulated for direct discharge in BPT, listed under NSPS (see Tables XII-1 and XIII-1) for a total of 137 nonconventional pesticides.

The priority pollutants proposed for regulation under PSES and PSNS include 25 pollutants listed under BAT in Table XII-2 and 9 pollutants, which were previously regulated for direct discharge in BPT, listed under NSPS (see Table XIII-2).

IDENTIFICATION OF PRETREATMENT STANDARDS

The derivation of pretreatment standards is similar to the derivation of effluent limitations presented in Section XII. This approach includes identifying technology options, option selection based on economic and technical aspects of implementing the regulation, identifying long-term averages, and calculating daily and monthly variability. The selection of long-term averages and treatment variability are discussed in Section XV (Selection of Effluent Limitations and Pretreatment Standards). The environmental significance of implementing PSES

standards for priority pollutants and nonconventional pesticides is discussed in Section XVI.

PSES Technology Options for Manufacturing Facilities

Two technology options have been developed for pretreatment standards for pesticide manufacturers. These options are presented in the following paragraphs.

Option 1--

Option 1 bases pretreatment standards for control of priority pollutants and nonconventional pesticide pollutants on pretreatment technology of pesticide removal (primarily adsorption or hydrolysis) and priority pollutant removal (primarily steam stripping, chemical oxidation, or metals separation, as required). The bulk of the priority pollutants and nonconventional pesticides would be removed prior to discharge to a POTW. The amount removed by pollutant/pollutant group is as follows:

Pollutant or Pollutant Group	Pollutant Removal (lbs/year)
Volatile Aromatics	95,100
Halomethanes	87,000
Cyanide	8,117
Phenols	37,440
Metals	13,620
Dienes	249

In addition, 3.331×10^5 pounds of priority pollutants (other than those listed above) and nonconventional pesticides would be removed per year through implementation of this option.

There would be an incremental capital cost of $12.3 million and an incremental annual treatment cost of $5.9 million for indirect dischargers associated with this option. Selection of this option is projected to result in the closure of two plants and two production lines.

This method is currently employed by well-operated plants in this industry and has been demonstrated to eliminate upset and interference at the POTW. Option 1, however, may not eliminate the pass-through potential.

Option 2--

Option 2 bases pretreatment standards for control of priority pollutants and nonconventional pesticides on Option 1 technology followed by biological treatment. Implementation of this option would result in the removal of additional pounds of priority pollutants by pollutant or pollutant group beyond Option 1 as follows:

Pollutant or Pollutant Group	Pollutant Removal (lbs/year)
Volatile Aromatics	10,380
Halomethanes	8,900
Cyanide	16.5
Phenols	3,744
Metals	360
Chlorinated Ethanes and Ethylenes	1,526
Dienes	6

In addition, 1,500 pounds of priority pollutants (other than those listed) and of nonconventional pesticides per year would be removed beyond Option 1.

There would be an incremental capital cost of $37,000 and an incremental annual treatment cost of $6.4 million for indirect dischargers associated with this option. Selection of this option is projected to result in the closure of 9 plants and 5 production lines.

Additional pollutant removal would be effected which might eliminate pass-through at the POTW. However, at present only one indirect discharger in the industry employs this level of treatment.

Economic Effects

A plant-by-plant treatment cost analysis was prepared in order to assess the effect on the industry of implementing two technology options. The results of this technical analysis were provided to the EPA pesticide economic contractor, so that the economic impact of the potential treatment costs on plant pesticide market value could be estimated.

All 117 manufacturing plants potentially affected by the Pesticide regulations were reviewed individually. For the PSES regulation, data from each of the 322 pesticides processes at these plants were evaluated and treatment units were costed for those priority pollutants and nonconventional pollutants detected or likely to exist in the wastewater at levels above the design levels recommended in Table XIV-1. Information on the process chemistry, raw waste load, treated waste load, type of disposal, current treatment practice, and flow were used in this review. The treatment units costed were selected according to the pollutants requiring removal as summarized in Table VI-22. The cost curves presented in Figures VIII-1 through VIII-22 were used in estimating costs based on actual wastewater flows.

Treatment cost estimates were based on the following criteria.

1. For those plants with effluent data exceeding design levels for priority pollutants and BPT levels for pesticides projected treatment was costed to bring the plant into compliance with the appropriate regulation.

2. For those plants without effluent data, it was assumed that pollutants germane to each process exist at effluent levels in excess of the design levels and appropriate treatment was costed accordingly.

3. Plant waste streams requiring similar treatment were assumed to use common treatment units.

4. Pesticide costs were proportioned based on pesticide flow. Where flow was unavailable, costs were proportioned based on production.

It should be noted that treatment cost estimates may in some cases be overestimated due to such factors as:

1. Treatment costs for activated carbon were based on the purchase of the activated carbon system and regeneration facilities. This is more expensive than the leasing of activated carbon systems which is prevalent in the industry.

2. Contract hauling has been costed to handle hazardous waste at $\$60/yd^3$. Disposal costs may be cheaper if wastes are determined to be nonhazardous.

Based on the above-mentioned analysis, plant costs were provided to the economic contractor. Those plants determined by the economic contractor to have treatment cost impacts greater than 4 percent of the pesticide market value were reviewed in greater depth. At each of these plants annual treatment costs were re-evaluated by basing the calculations on the actual daily production rather than on previously assumed full year production. Additionally, capital costs were revised to accommodate only the largest pesticide flow to be treated over the period of one year rather than the daily production of all manufactured pesticides as previously assumed. Treatment costs were estimated only for those priority pollutants and nonconventional pollutants to be regulated.

The results of this analysis are summarized below and in the following table. Of the 117 plants and 322 pesticide wastewater streams considered, it is anticipated that between 17 and 30 POTW dischargers will require additional pollutant removal as a result of implementing the design effluents. This could affect between 45 and 78 pesticide wastewater streams from POTW dischargers depending upon the recommended level of treatment selected for regulation.

Economic Effect of Implementing Design Levels

Sub-category	POTW Level 1 Capital ($1000s)	POTW Level 1 Annual ($1000s)	POTW Level 2* Capital ($1000s)	POTW Level 2* Annual ($1000s)
1	1,790	1,290	4,040	1,130
2	4,930	3,110	11,200	3,560
3	2,920	1,770	5,790	2,780
4	0	15	1,890	510
5	0	0	1,580	462
6	0	0	124	32
7	0	0	139	37
8	0	0	3,100	1,150
9	3,140	1,920	5,550	1,640
10	174	85	456	118
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0

* Level 2 cost is in addition to Level 1 cost.

The same treatment costs are summarized for all affected plants in the industry as follows:

	Priority Pollutant and Nonconventional Pesticide Removal POTW Level 1	Priority Pollutant and Nonconventional Pesticide Removal POTW Level 2*
No. of Plants Affected	17	30
No. of Pesticide Processes Affected	45	78
Capital Cost ($1000s)	12,900	33,900*
Annual Cost ($1000s)	8,190	11,400*

* Level 2 costs in addition to Level 1 costs.

In order to demonstrate the portion of the total treatment cost estimate devoted strictly to nonconventional pesticide removal, the following table is presented.

	Nonconventional Pesticide Removal POTW Level 1	Nonconventional Pesticide Removal POTW Level 2*
No. of Plants Affected	8	19
No. of Pesticide Processes Affected	14	38
Capital Cost ($1000s)	6,430	9,220*
Annual Cost ($1000s)	4,220	3,240*

* Level 2 costs in addition to Level 1 costs.

Option 1 for PSES includes Level 1 technology. The total incremental costs associated with this option would be 12.9 million dollars capital and 8.2 million dollars annual.

Option 2 for PSES includes Level 2 technology. This option is considerably more expensive with an incremental cost of 33.9 million dollars capital and 11.4 million dollars annual for indirect dischargers.

PSNS Technology Options for Manufacturing Facilities

New indirect discharge manufacturers have the opportunity to incorporate the best available demonstrated technologies including process changes, in-plant control measures, and end-of-pipe treatment, and to use plant site selection to ensure adequate treatment system installation. The pretreatment options available for new dischargers to POTWs are the same as those presented for PSES. PSNS treatment costs were projected for model manufacturing facilities in each subcategory for Options 1 and 2. These treatment cost estimates may in some cases be overestimated since it is assumed that a plant would require all technologies recommended for each subcategory. Tables XIV-2 and XIV-3 present the PSNS estimated costs for Option 1/Level 1 (physical/chemical treatment) and Option 2/ Level 2 (physical/chemical and biological treatment), respectively.

Selection of Pretreatment Technology for Manufacturing Facilities

Option 1/Level 1 treatment technology (physical/chemical treatment) is proposed for control of priority pollutants and nonconventional pesticides for indirect dischargers under PSES and PSNS regulations. An exception is that PSES/PSNS for Subpart N (Subcategory 11) shall be equal to BPT, which is being proposed as no discharge of process wastewater.

Although Option 1 may present a pass-through potential, Option 2, with decreased pass-through potential, would have high costs and considerable economic impacts. In addition, biological treatment prior to treatment at a POTW (Level 2 for Option 2) is not proposed at this time. The implementation of Level 1 control technology ensures minimal discharge of the priority pollutant metals copper and zinc, minimizing such problems as sludge disposal and pass-through. Discharge of priority pollutant volatile organics and cyanide is also greatly decreased. Many plants in this industry are currently achieving Option 1 levels of control.

PSES Regulatory Options for Select Metallo-Organic Pesticide Manufacturers

The metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products were not researched during the early development stages of these regulations. However, at that time, the current state-of-the-art was such that no discharge of process wastewater pollutants was being achieved through the application of recycle technology. Therefore, existing direct discharge manufacturers of metallo-organic pesticides containing mercury, copper, cadmium, or arsenic were

regulated at zero discharge during BPT. Current review of available information indicates that select metallo-organic manufacturers maintain zero discharge. Additional technical and economic data have been collected for this portion of the industry subsequent to promulgation of the BPT regulation. However, since manufacturers of these pesticides conduct the same types of process operations regardless of mode of discharge, the BPT data base can be applied to the indirect discharge metallo-organic manufacturers. EPA has therefore selected the BPT technology of total recycle or reuse, evaporation, or contract hauling of process wastewater as the basis for proposed PSES for metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products. Implementation of this option will establish regulatory consistency with the BPT effluent limitation. Annual and capital costs for this technology level will vary depending on the treatment used as shown in Table XIV-4. For example, if Solar Evaporation is used, capital costs for installation of this technology in a 500-GPD flow will range from $42,000 to $160,000. Annual costs will range from $10,500 to $28,000.

PSES Regulatory Options for Formulator/Packagers

The indirect discharge formulator/packager segment of the industry was not researched during the early development stages of these regulations. However, direct discharge formulator/packagers were regulated at zero discharge under BPT, based in part on data supplied by indirect discharge formulators. These data, along with current information, show that approximately 90 percent of all formulator/packagers in that data base do not generate process wastewater. The remaining plants in the data base generate low volume, highly concentrated wastewater from such controls as washout of reaction vessels or air emissions scrubbers. These plants typically evaporate or contract haul these wastes to meet the current BPT zero discharge limitation. Additional technical and economic data have been collected for this portion of the industry subsequent to promulgation of the BPT regulation. The Agency believes that formulator/packagers conduct the same types of operations regardless of mode of discharge. The Agency solicits any comments from the industry pertaining to this matter. Accordingly, the Agency is basing pretreatment standards for indirect discharger formulator/packagers on the BPT technology of total evaporation or contract hauling. Implementation of this option will establish regulatory consistency with the BPT effluent limitations for direct dischargers. Annual and capital costs for implementation of this technology level shown in Table XIV-5 will be the same as the costs for the metallo-organic portion of the industry.

Selection of Long-Term Averages

The long-term average effluents for indirect dischargers are defined in Section XV for manufacturers, including metallo-organic manufacturers of mercury, copper, cadmium, and arsenic-based products, and formulator/packagers.

Treatment Variability

Effluent variability factors for indirect dischargers are defined in Section XV. Daily and monthly factors are applied to long-term averages in order to derive pretreatment standards.

Pretreatment Standards

PSES and PSNS pretreatment standards guidelines for indirect dischargers are presented in Tables II-33 through II-45.

Table XIV-1. Indirect Discharge Design Effluent Levels*

Pollutant Group†	LEVEL 1** Indirect Discharger (mg/l)	LEVEL 1** Indirect Discharger (lbs/1,000 lbs)	LEVEL 2†† Indirect Discharger (mg/l)	LEVEL 2†† Indirect Discharger (lbs/1,000 lbs)
Volatile Aromatics	1.0	0.037	<0.01	<0.00037
Halomethanes	1.0	0.037	<0.01	<0.00037
Cyanides	0.04	0.0015	0.02	0.00075
Haloethers	1.0	0.037	0.05	0.0019
Phenols	1.0	0.037	0.1	0.0037
Polynuclear Aromatics	1.0	0.037	0.1	0.0037
Metals	0.5	0.019	0.25	0.0094
Chlorinated Ethanes (ylenes)	1.0	0.037	0.1	0.0037
Nitrosamines	0.001	0.000037	0.001	0.000037
Dienes	0.045	0.0017	0.023	0.00086
Pesticides	1.0	0.037	0.5	0.019
BOD	1,470	55.2	30	1.13
COD	3,890	146	586	22.0
TSS	N/A	—	35	1.31

* Long-term average effluents demonstrated or judged achievable (as presented in Section VI) from maximum design raw waste load levels (as presented in Section V). Design effluents used for cost analyses only.

† Pollutant groups excluded are not known to be present at or above the level of interest.

** Level 1 for indirect dischargers (POTW, etc.) includes pretreatment by steam stripping, chemical oxidation, metals separation, adsorption by resin or carbon, or hydrolysis as appropriate.

†† Level 2 includes indirect discharge Level 1 plus biological oxidation.

N/A = Not applicable.

lbs/1,000 lbs = 4,500 gal/1,000 lbs x 8.34 x mg/l (where 4,500 gal/1,000 lbs is design flow for industry).

Table XIV-2. Option 1 PSNS Costs for Manufacturers

Subcategory	Cost ($1,000s)*			
	Capital		Annual	
	High	Low	High	Low
1	1,150	360	560	190
2	1,730	600	770	270
3	6,000	1,420	4,000	800
4	1,700	800	1,000	540
5	3,000	1,000	1,900	520
6	0	0	100	42
7	1,400	800	900	460
8	1,800	500	850	260
9	2,100	710	1,000	370
10	3,600	1,400	2,200	1,100
11†	0	0	0	0

* High and low costs reflect differences in degree of treatability or differences in recoveries obtainable.

† Proposed for regulation at zero discharge.

Table XIV-3. Option 2 PSNS Costs for Manufacturers

Subcategory	Cost ($1,000s)*			
	Capital		Annual	
	High	Low	High	Low
1	2,200	1,300	800	410
2	2,500	1,500	1,000	530
3	8,000	3,300	4,600	1,300
4	2,700	1,700	1,300	800
5	4,200	2,300	2,300	900
6	0	0	100	42
7	2,200	1,600	1,100	650
8	2,800	1,600	1,100	500
9	3,200	1,800	1,300	680
10	5,200	2,800	2,600	1,500
11†	0	0	0	0

* High and low costs reflect differences in degree of treatability or differences in recoveries obtainable.

† Proposed for regulation at zero discharge.

Table XIV-4. Option 1 PSES Costs for Indirect Discharge Metallo-Organic Manufacturers

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE - Net evaporation.
psi = Pounds per square inch.

Table XIV-5. Option 1 PSES Costs for Indirect Discharge Formulator/Packagers

	Average Flow (gpd)								
	5,000			500			50		
	Capital	Annual	Energy	Capital	Annual	Energy	Capital	Annual	Energy
Contract Hauling									
Hazardous	—	$446,000	—	—	$44,600	—	—	$4,460	—
Nonhazardous	—	$186,000	—	—	$18,600	—	—	$1,860	—
Evaporation									
Solar									
(5 in/yr NE)	$1,200,000	$170,000	—	$160,000	$28,000	—	$28,000	$6,700	—
(10 in/yr NE)	$640,000	$100,000	—	$92,000	$18,000	—	$16,500	$5,600	—
(20 in/yr NE)	$350,000	$58,000	—	$62,000	$13,000	—	$13,000	$4,400	—
(30 in/yr NE)	$230,000	$46,000	—	$42,000	$10,500	—	$9,200	$4,400	—
Spray									
(10 psi)	$90,000	$50,000	$13,000	$16,400	$11,000	$240	$10,700	$4,200	$150
(5 psi)	$145,000	$66,000	$20,000	$24,000	$11,900	$400	$12,000	$4,600	$165

NE = Net evaporation.
psi = Pounds per square inch.

SECTION XV

SELECTION OF BAT AND NSPS EFFLUENT LIMITATIONS AND PRETREATMENT STANDARDS FOR EXISTING (PSES) AND NEW SOURCES (PSNS)

BAT and NSPS effluent limitations and PSES and PSNS pretreatment standards were derived by selecting the long-term averages for each regulated pollutant (nonconventional pesticides, priority pollutants, BOD, TSS, pH, or COD as appropriate for each regulation) and by applying daily and monthly variability factors to determine the daily and 30-day average maximum levels.

Information presented in this section includes: (1) the selection of long-term averages, which is based on an evaluation of effluents actually achieved in the industry and those estimated to be achievable through the application of best available technology, and (2) the development of effluent variability factors.

SELECTION OF LONG-TERM AVERAGES

The first step in selecting long-term averages was to determine which treatment technology option should be implemented for each regulation.

Based on the previous discussion of treatment options and economic effects, the selection of long-term averages was derived for BAT and NSPS by utilizing the selected option of pretreatment by steam stripping, chemical oxidation, metals separation, pesticide removal by activated carbon, resin adsorption, or hydrolysis, followed by biological treatment. Whereas the selection of long-term averages was derived for PSES and PSNS by utilizing the selected option of pretreatment by steam stripping, chemical oxidation, metals separation, pesticide removal by activated carbon, resin adsorption, or hydrolysis with no biological treatment.

The second step in selecting long-term averages is to determine the effluents achieved and achievable as described below.

Effluents Achieved

The actual effluents achieved by plants in the industry are summarized in Tables XV-1 through XV-18. The pesticide code name and associated plant, subcategory for the pesticide, number of data points available, and existence of the recommended activated carbon, resin adsorption, hydrolysis, steam stripping, chemical oxidation, or metals separation treatment technology for direct and indirect dischargers are all presented for evaluation. These data will be used for comparison with the long-term averages judged achievable as the basis for effluent limitations or pretreatment standards.

Effluents Achievable

It is the purpose of this subsection to define the effluent achievable for each parameter to be regulated at both indirect and direct discharge levels. To do this the effluents currently being achieved were compared to design effluent level concentrations and/or lbs/1,000 lbs. If effluents achieved were larger than design effluents, then transfer technology and treatability data for recommended technologies were used in order to estimate the effluent achievable. If effluents achieved were less than design effluents, then no estimation was necessary. These evaluations are presented first for 34 priority pollutants, then the 137 nonconventional pesticides to be regulated (see individual regulation sections for pollutants to be regulated).

Priority Pollutants--Priority pollutant effluents achievable are defined by group as follows:

Volatile Aromatics--Benzene is one of the six volatile aromatic priority pollutants proposed to be regulated. Although there are no full-scale data in the pesticide industry which document the removal efficiency of benzene via the recommended steam stripping treatment system, treatability evaluations by Hwang and Fahrenthold (1980) predict that benzene can be stripped from 2,600 to 0.05 mg/l. A steam stripping pretreatment effluent of 1.0 mg/l is predicted to be achievable, based on the assumption that the system designed in Section VI of this report will operate less efficiently than that of Hwang.

Based on full-scale data from biological treatment systems operating at Plants 1, 2, and 3 benzene has been shown to be reduced from levels of 2.68 mg/l to less than 0.01 mg/l. It is therefore concluded that a combination of steam stripping and biological oxidation can reduce benzene to the direct discharge effluent achievable value of less than 0.01 mg/l.

Chlorobenzene is produced as a pesticide by three manufacturers in the pesticide industry; however, there are no data available which document the removal of chlorobenzene via the recommended pretreatment of steam stripping. As a result of a treatability evaluation, Hwang and Fahrenthold (1980) have reported that chlorobenzene can be reduced to 0.05 mg/l following steam stripping. This system has an overall column efficiency rating of 100 percent. A pretreatment effluent achievable value for chlorobenzene in the pesticide industry is 1.0 mg/l, based on a 12-percent column efficiency as assumed in this report.

Full-scale operating data from Plants 4 and 5 have shown that chlorobenzene can be reduced to <0.01 mg/l, a >99.7 percent removal, following biological oxidation. It is therefore concluded that chlorobenzene pretreated to 1.0 mg/l via steam stripping can be further reduced to a direct discharge effluent achievable value of <0.01 mg/l following biological oxidation.

The recommended pretreatment for toluene is steam stripping. Plant 229 operates a full-scale vacuum stripper, as opposed to a steam stripper, in order to minimize the amount of toluene present during regeneration of their subsequent resin system. This system is designed to achieve an effluent level of 10 mg/l toluene; however, plant monitoring shows that toluene is routinely reduced to only 24.2 to 29.1 mg/l. A treatability evaluation by Hwang and Fahrenthold (1980) predicted that toluene can be reduced from 535 mg/l to 0.05 mg/l via steam stripping at 100-percent overall efficiency. Based on the 12-percent tray efficiency level of the steam stripper designed in this report, the pretreatment effluent achievable for toluene is predicted to be 1.0 mg/l.

Full-scale biological treatment systems at Plants 6, 7, 8, 9, and 10 have reduced toluene concentrations to <0.01, <0.01, 0.009, <0.01, and 0.005 mg/l, respectively. Therefore, it is concluded that following steam stripping and biological oxidation, the effluent achievable value for direct discharges of toluene in the pesticide industry is <0.01 mg/l.

The three remaining volatile aromatic priority pollutants proposed for regulation are 1,2-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene. Since these pollutants are proposed for regulation only in those processes in which it is the manufactured pesticide product, the effluents achievable are presented under Subcategory 2 for the nonconventional pesticide parameter.

Halomethanes--Although no full-scale data are available in the pesticide industry to document the removal of carbon tetrachloride (CCl_4) via the recommended treatment system of steam stripping, treatability evaluations compiled by Hwang and Fahrenthold (1980) demonstrate that CCl_4, like other halomethanes, can be reduced to 0.05 mg/l following steam stripping operating at 100-percent overall efficiency. Based on the lower efficiency rate of the steam stripper designed in this report, a pretreatment effluent of 1.0 mg/l for CCl_4 is therefore judged to be achievable.

In the pesticide industry, only data from Plant 11 have been supplied which document the removal of CCl_4 through biological oxidation. A removal efficiency of 73 percent with an influent of 1.0 mg/l and an effluent of 0.270 mg/l was reported for CCl_4 at Plant 11. A treatability study by Coco (1978) revealed that CCl_4 can be reduced to <0.01 mg/l following air stripping in biological treatment. Effluent data from biological systems for similar halomethanes show levels equal to or less than 0.01 mg/l for methylene chloride (Plant 23) and chloroform (Plants 14, 15, and 16). It is therefore concluded that the effluent achievable value for CCl_4 is <0.01 mg/l for direct dischargers.

Treatability evaluations by Hwang and Fahrenthold (1980) show that chloroform can be reduced to 0.05 mg/l following the recommended pretreatment of steam stripping operating at 100-percent overall efficiency. Chloroform has been reduced by 98.4 percent to <0.001 mg/l at Plant 12 utilizing steam stripping. However, the value of <0.001 mg/l

reported for Plant 12 was not conducted per protocol. Full-scale operating data from Plant 13 show that chloroform can be reduced to the plant detection limit of <5.0 mg/l via steam stripping treatment. The steam stripping treatment system designed in this report provides more capacity (tray efficiency of 12 percent versus 25 percent) than the system utilized by Plant 13. Therefore, it is judged that the pretreatment effluent achievable for chloroform following stream stripping is 1.0 mg/l for indirect dischargers.

Based on full-scale operating data from Plants 14, 15, and 16, chloroform can be further removed to <0.01 mg/l following biological oxidation. It is concluded that the effluent achievable value for chloroform is <0.01 mg/l following steam stripping pretreatment and biological oxidation for direct dischargers.

Methyl bromide is produced by Plants 17 and 18; however, there are no data available which document the removal of methyl bromide via the recommended pretreatment of steam stripping. Hwang and Fahrenthold (1980) have reported that methyl bromide can be reduced to 0.05 mg/l following steam stripping using an overall column efficiency rating of 100 percent. The pretreatment effluent achievable value for methyl bromide in the pesticide industry is 1.0 mg/l, based on a 12-percent column efficiency as assumed in this report.

Full-scale operating data from Plant 18 have shown that methyl bromide can be reduced from 1.110 mg/l to 0.011 mg/l, a 99 percent removal, following biological oxidation. Plant 17 deep well injects methyl bromide wastewater. It is concluded that methyl bromide pretreated to 1.0 mg/l via steam stripping can be further reduced to a direct discharge effluent achievable value of <0.01 mg/l, as demonstrated by Plants 19, 20, and 21 for other halomethanes, following biological oxidation.

There are no data available in the pesticide industry which document the removal of methyl chloride via the recommended steam stripping treatment system. However, a treatability evaluation by Hwang and Fahrenthold (1980) has predicted that methyl chloride can be reduced to 0.05 mg/l following steam stripping utilizing six actual trays and aqueous reflux, at 100-percent efficiency. Based on the assumption that the steam stripping system designed in this report is less efficient than Hwang and Fahrenthold, the pretreatment effluent achievable for indirect dischargers is 1.0 mg/l methyl chloride following steam stripping.

Treatability studies by Coco (1978) have demonstrated that methyl chloride can be reduced to <0.01 mg/l following air stripping in biological treatment systems. In the pesticide industry there are no data available to document the removal of methyl chloride through biological oxidation. However, effluent data from biological systems for similar halomethanes show levels equal to or less than 0.01 mg/l for methylene chloride (Plant 23) and chloroform (Plants 14, 15, and 16). The effluent achievable for methyl chloride is therefore <0.01 mg/l

following steam stripping pretreatment and biological oxidation for direct dischargers.

A full-scale system removing methylene chloride is demonstrated to achieve <0.01 mg/l at Plant 22, using the recommended treatment of steam stripping. Although these data were not conducted per protocol, the percent removal conforms to plant design. Treatability studies by Hwang and Fahrenthold (1980) have demonstrated that methylene chloride can be reduced to 0.05 mg/l via steam stripping at 100-percent efficiency. Based on the above, the pretreatment effluent achievable for methylene chloride in the pesticide industry is 1.0 mg/l for indirect dischargers, assuming that the stream stripping system designed in this report is less efficient than that of Hwang and Fahrenthold.

A value of 0.01 mg/l methylene chloride has been reported for Plant 23 following biological oxidation. Coco's (1978) treatability study has demonstrated that air stripping in biological treatment can reduce methylene chloride to <0.01 mg/l. The combination of steam stripping and biological oxidation is therefore predicted to achieve a direct discharge effluent value of <0.01 mg/l in the pesticide industry.

Cyanide--Chemical oxidation pretreatment for cyanide in the pesticide industry is in operation at Plant 24. This treatment system was designed by the plant to reduce cyanide levels to less than 1.0 mg/l. The only data available from this system were not conducted according to protocol. Transfer technology from the electroplating industry demonstrates that 36 percent of all plants with this technology achieve total cyanide effluent of less than 0.04 mg/l. It is concluded that a proposed effluent of 0.04 mg/l is similarly achievable in the pesticide industry.

Data from full-scale biological treatment systems at Plants 25, 26, and 27 have shown an average reduction of 50 percent achievable for cyanide. The proposed effluent achievable for direct dischargers following pretreatment (chemical oxidation) and biological oxidation is therefore 0.02 mg/l.

Haloethers--Bis(2-chloroethyl) ether (dichloroethyl ether) is proposed for regulation only in those processes in which it is the manufactured product. No process wastewater discharge via total evaporation has been reported by the one manufacturer, Plant 28. Therefore, a zero discharge effluent is achievable. In all other processes, bis(2-chloroethyl) is proposed to be excluded from regulation pending the collection of adequate monitoring data.

Phenols--The priority pollutant 2,4-dichlorophenol is one of the five phenols proposed to be regulated. Full-scale systems removing 2,4-dichlorophenol are demonstrated to achieve <0.022 and 0.82 mg/l at Plants 29 and 30, respectively, using the recommended treatment of activated carbon. Plant 31 has shown an effluent of <0.462 mg/l using the recommended resin adsorption treatment. Considering maximum raw waste

loads throughout the industry for all phenols (100 to 42,000 mg/l), it is concluded that a pretreatment effluent of 1.0 mg/l is achievable in the pesticide industry.

Full-scale biological treatment system data from Plants 32 and 33 show that 2,4-dichlorophenol can be reduced by 93.8 and >97.6 percent, respectively. Assuming a reasonable 90-percent removal of 2,4-dichlorophenol through biological oxidation, the effluent achievable for direct dischargers following activated carbon or resin adsorption pretreatment and biological oxidation is therefore 0.1 mg/l.

Although no full-scale data are available in the pesticide industry to document the removal of 2,4-dinitrophenol via the recommended treatment systems of activated carbon or resin adsorption, carbon adsorption isotherm data compiled by Dobbs, et al. (1978) demonstrated that 2,4-dinitrophenol can be reduced to 1.0 mg/l following activated carbon adsorption. Resin adsorption pilot scale data from Plant 34 have shown that another nitrated phenol priority pollutant, 4-nitrophenol, can be reduced from 1,000 to 1.0 mg/l. Therefore, the pretreatment effluent achievable for 2,4-dinitrophenol is 1.0 mg/l.

Plant 35 has reported that 2,4-dinitrophenol can be reduced by 95 percent from 7.91 to 0.397 mg/l following biological treatment. It is therefore concluded that 2,4-dinitrophenol pretreated to 1 mg/l can be further reduced by a reasonably estimated 90 percent to a direct discharge achievable effluent of 0.1 mg/l, following activated carbon or resin adsorption and biological oxidation.

Resin adsorption pilot scale data provided by Plant 36 have shown 4-nitrophenol to be reduced from 1,000 to 1.0 mg/l. Activated carbon adsorption isotherm data by Calgon (1980) indicate that 4-nitrophenol can be reduced to a concentration of 1.0 mg/l following carbon adsorption. Based on the above, the pretreatment effluent achievable for 4-nitrophenol is 1.0 mg/l.

Full-scale biological treatment operating data from Plants 37 and 38 have shown that greater than 94 and 99 percent removal of 4-nitrophenol respectively, can be achieved. Therefore, it is judged that a combination of resin adsorption or activated carbon followed by biological oxidation can conservatively reduce 4-nitrophenol to an effluent achievable value of 0.1 mg/l for discharges to navigable waters.

As shown by Dobbs, et al. (1978), carbon isotherm data for pentachlorophenol (PCP) indicated that PCP can be reduced to 1.0 mg/l following carbon adsorption. PCP is produced as a pesticide by three manufacturers in the pesticide industry; however, neither activated carbon nor resin adsorption has been utilized as a method of wastewater treatment. A removal rate of 90 percent for PCP from <0.10 mg/l via activated carbon has been reported for Plant 39; however, these analyses were not conducted per protocol. Data from activated carbon systems (Plants 40 and 41) and a resin adsorption system (Plant 42) showed that other chlorinated phenols, such as 2-chlorophenol, 2,4-dichlorophenol,

and 2,4,6-trichlorophenol, were reduced to less than 1.0 mg/l. Based on the above, the pretreatment effluent achievable for PCP is 1.0 mg/l.

Full-scale data from biological treatment systems operating at Plants 43 and 44 have shown that PCP can be reduced to less than 0.4 mg/l--a 40-percent removal efficiency. Transfer technology from the timber industry demonstrates that PCP can be reduced through biological oxidation by 97.3 percent and greater for wood preserving plants. It is concluded that an effluent for direct dischargers of 0.1 mg/l is achievable in the pesticide industry, based on 90-percent removal in biological systems as demonstrated for other chlorinated phenols.

Activated carbon operating data from Plants 45 and 46 in the pesticide industry have shown that phenol concentrations can be reduced to <0.081 and 0.029 mg/l, respectively. A pretreatment effluent of 1.0 mg/l can therefore be conservatively achieved.

Full-scale biological systems treating phenolic wastes are operating at Plants 47, 48, 49, and 50. Data from all four plants have shown a 90 percent or greater average reduction for phenol, with an influent value as high as 1,100 mg/l reported for Plant 49. The effluent achievable for direct dischargers is therefore 0.1 mg/l for phenol.

Metals--Full-scale data from Plant 51 demonstrate that copper can be reduced to 2.2 mg/l. The metals separation treatment system at Plant 52 uses hydrogen sulfide precipitation, as described in Section VI of this report. The recommended treatment system for metals removal in the pesticide industry consists of high pH chemical precipitation followed by a filter press. This system is comparable to copper removal systems used in the electroplating industry. Transfer technology data from 25 plants in the electroplating industry show that copper can be reduced to an average of 0.49 mg/l following pH adjustment (at an optimum pH of 9.0) and clarification. It is concluded that a pretreatment effluent of 0.5 mg/l is similarly achievable in the pesticide industry.

Full-scale data from biological treatment systems operating at Plants 53, 54, and 55 show that copper can be reduced by approximately 50 percent following biological oxidation. The effluent achievable for direct dischargers is therefore 0.25 mg/l copper following the recommended treatment of metals separation and biological oxidation.

Although there are no full-scale data available in the pesticide industry to document the removal efficiency of zinc via a metals separation treatment system, transfer technology data from the coil coating industry demonstrate that zinc can be reduced to 0.5 mg/l following lime settling precipitation and to 0.25 mg/l following lime settling/filtration (Hall, 1980). Transfer technology data from 25 plants in the electroplating industry demonstrate that zinc can be reduced to 0.72 mg/l following pH adjustment and clarification. The recommended metals separation treatment system for the pesticide industry, as described in Section VI of this report, is comparable to the systems used in the battery and electroplating industries with the

addition of a filter press. Plant 56 has in place ferric sulfate and lime precipitation treatment, which is designed primarily for the removal of arsenic and zinc from surface water runoff. There are no data available to document the removal of zinc through the chemical precipitation treatment step of the surface water treatment system. However, an evaporator/crystallizer treatment system is also used at Plant 56 for the removal of pesticides and metals from process wastewater. This evaporator/crystallizer system concentrates pesticide wastewater to a slurry of 25 percent suspended solids by a Swenson double effect evaporator. The influent zinc concentration was found to be 248 mg/l during verification sampling. The evaporator condensate or effluent concentration was 0.18 mg/l zinc, with a removal efficiency of 99.9 percent. It is concluded that the evaporator/crystallizer treatment system achieves the same result as the metals separation system designed in this report. Based on the above, the pretreatment effluent achievable for zinc in the pesticide industry is judged to be 0.5 mg/l.

Plant 57 has a full-scale biological treatment system in operation. Data from this plant show a removal efficiency of 77.4 percent for zinc through biological oxidation to a level of 0.120 mg/l. Based on a reasonable assumption of 50 percent removal through biological oxidation, the zinc effluent achievable for the pesticide industry is therefore 0.25 mg/l, following the recommended treatment of metals separation and biological oxidation.

Chlorinated Ethanes and Ethylenes--At Plant 58 a full-scale steam stripping system, which is the recommended pretreatment for chlorinated ethanes, was recently installed to remove 1,2-dichloroethane from pesticide and pesticide intermediate process wastewater. However, no data are currently available to document the removal of this solvent via steam stripping for Plant 58. Treatability evaluations by Walk and Haydell (1978) established that steam stripping is theoretically feasible for 1,2-dichloroethane due to its 9,000-mg/l solubility in water and boiling point of 83.5°C. Similarly, Hwang and Fahrenthold (1980) reported that 1,2-dichloroethane, with an activity coefficient of 173 and a vapor pressure of 167 kPa, at 100°C, can be reduced to 0.05 mg/l following steam stripping treatment operating at 100-percent overall efficiency. It is therefore predicted that the pretreatment effluent achievable for indirect dischargers is 1.0 mg/l for 1,2-dichloroethane, assuming that the steam stripping system designed in this report is only 12 percent tray efficient.

Full-scale operating data for Plants 59 and 60 show approximately 50 percent removal of 1,2-dichloroethane through biological oxidation to effluent levels of 0.58 and 0.18 mg/l, respectively. Other priority pollutant chlorinated ethanes and ethylenes have been reduced by greater than 90 percent through biological oxidation. For example, full-scale data from Plant 61 demonstrate that 1,1,1-trichloroethane and 1,1-dichloroethylene can achieve effluent levels of 0.022 mg/l (94.9 percent removal) and 0.041 mg/l (96.3 percent removal), respectively, following biological oxidation. Assuming a 90-percent removal of 1,2-dichloroethane through biological oxidation, as has been demonstrated for other

chlorinated ethanes and ethylenes, the effluent achievable for direct dischargers following steam stripping pretreatment and biological oxidation is therefore 0.1 mg/l.

Although there are no full-scale data to document the removal of tetrachloroethylene via the recommended pretreatment of steam stripping, treatability evaluations by Walk, Haydel, and Associates (1978) and Hwang and Fahrenthold (1980) have demonstrated the feasibility of steam stripping as a method of removing tetrachloroethylene from industrial wastewater. Hwang and Fahrenthold indicate that at a vapor pressure of 53.3 kPa, at 100°C, tetrachloroethylene can be theoretically reduced to 0.05 mg/l via steam stripping treatment operating at 100 percent overall efficiency. A pretreatment effluent value of 1.0 mg/l is predicted to be achievable for tetrachloroethylene for indirect dischargers via steam stripping technology designed in this report at 12 percent tray efficiency.

Based on full-scale data from a biological treatment system operating at Plant 62, tetrachloroethylene has been shown to be reduced by 89 percent to a concentration of 0.037 mg/l. An effluent for direct dischargers of 0.1 mg/l tetrachloroethylene is therefore achievable in the pesticide industry, based on 90-percent removal in biological systems.

Nitrosamines--Plant 63 has in place the recommended carbon pretreatment for N-nitrosodi-n-propylamine. Activated carbon effluent concentrations of 0.0067 mg/l (0.000038 lb/1,000 lbs) from 20 months of plant monitoring and 0.0041 mg/l from verification monitoring for n-nitrosodi-n-propylamine have been reported for Plant 63. The accuracy of the plant data is judged acceptable. Therefore, the pretreatment effluent achievable is 0.000038 lb/1,000 lbs (equivalent to 0.001 mg/l at the design flow for the industry).

Full-scale biological treatment and tertiary sand filtration at Plant 64 have shown an effluent n-nitrosodi-n-propylamine level from all plant sources of <0.00024 lb/1,000 lbs. This is an apparent increase in pollutant from the activated carbon effluent of 0.000038 lb/1,000 lbs due to an unknown amount of n-nitrosodi-n-propylamine being generated by nonpesticide process wastewater sources, and due to reduced analytical sensitivity at the final plant discharge where flow is greatly diluted. Until additional data are gathered it is recommended that the direct discharge effluent achievable for n-nitrosodi-n-propylamine from pesticide active ingredient be considered equal to the pretreatment level of 0.000038 lb/1,000 lbs and that monitoring of the segregated carbon effluent be required.

Dichloropropane and Dichloropropene--The pollutant 1,3-dichloropropene is proposed for regulation only in those processes in which it is the manufactured product. No process wastewater discharge has been reported by the manufacturers Plant 65 and Plant 66. Therefore, a zero-discharge effluent is achievable.

In all other processes, 1,3-dichloropropene is proposed to be excluded from regulation pending the collection of adequate monitoring data.

Based on previously-mentioned treatability studies by Walk and Haydell (1978) and, full-scale data reported for Plant 67, as with 1,2-dichloropropane, 1,3-dichloropropene can similarly achieve an effluent value of 0.1 mg/l for direct dischargers following steam stripping and biological oxidation.

Dienes--The recommended pretreatment for hexachlorocyclopentadiene (HCCPD) in the pesticide industry is activated carbon or resin adsorption. Plant 68 uses a resin adsorption treatment system to reduce levels of HCCPD. Resin effluent data have shown that HCCPD can be reduced to 0.123 mg/l according to verification data and 0.034 mg/l (0.0017 lb/1,000 lbs) according to plant monitoring during the December 1976 to June 1977 EPA demonstration grant at Plant 68. Treatability studies by Aware (1979) have shown 99.5 percent removal of HCCPD to an average effluent concentration of 0.0055 mg/l following resin adsorption of a larger flow than the demonstration grant. Based on the full-scale data described above, the pretreatment effluent achievable for HCCPD in the pesticide industry is 0.0017 lb/1,000 lbs (equivalent to 0.045 mg/l at the design flow for the industry).

There are no plants in the pesticide industry which currently use biological oxidation to treat priority pollutant dienes. Dienes have low solubility in water and like metals will adsorb on sludge rather than biodegrade or volatilize. The removal rate of metals through biological oxidation has been documented in the pesticide industry and is approximately 50 percent. The effluent achievable for direct discharge of HCCPD in the pesticide industry is therefore predicted to be 0.023 mg/l (0.00085 lb/1,000 lbs) following activated carbon or resin adsorption pretreatment and biological oxidation.

Priority Pollutant Pesticides--The BPT effluent long-term average for BHC-alpha is 0.0344 mg/l for direct dischargers using pesticide removal. The pretreatment effluent achievable for BHC-alpha is therefore 0.0344 mg/l for indirect dischargers following the recommended pesticide removal pretreatment of activated carbon, resin adsorption, or hydrolysis. This compound is not currently manufactured and has not been monitored in the pesticide industry.

The BPT effluent long-term average for BHC-beta is 0.0344 mg/l for direct dischargers using pesticide removal. The pretreatment effluent achievable for BHC-beta is therefore 0.0344 mg/l for indirect dischargers following the recommended pesticide removal pretreatment of activated carbon, resin adsorption, or hydrolysis. This compound is not currently manufactured and has not been monitored in the pesticide industry.

The BPT effluent long-term average for BHC-delta is 0.0344 mg/l for direct dischargers using pesticide removal. The pretreatment effluent achievable for BHC-delta is therefore 0.0344 mg/l for indirect

dischargers following the recommended pesticide removal pretreatment of activated carbon, resin adsorption, or hydrolysis. This compound is not currently manufactured and has not been monitored in the pesticide industry.

The BPT effluent long-term average for endosulfan-alpha is 0.0344 mg/l for direct dischargers using pesticide removal. The pretreatment effluent achievable for endosulfan-alpha is therefore 0.0344 mg/l for indirect dischargers following the recommended pesticide removal pretreatment of activated carbon, resin adsorption, or hydrolysis. This compound is not currently manufactured and has not been monitored in the pesticide industry.

The BPT effluent long-term average for endosulfan-beta is 0.0344 mg/l for direct dischargers using pesticide removal. The pretreatment effluent achievable for endosulfan-beta is therefore 0.0344 mg/l for indirect dischargers following the recommended pesticide removal pretreatment of activated carbon, resin adsorption, or hydrolysis. This compound is not currently manufactured and has not been monitored in the pesticide industry.

Endrin was previously regulated for direct discharge under 307(a) of the Act in 1977 and under BPT in 1978. The BPT effluent long-term average for endrin is 0.0344 mg/l using pesticide removal. The BAT recommended pretreatment for pesticides is activated carbon, resin adsorption, or hydrolysis. Full-scale plant data from Plant 69 have shown that endrin is reduced to <0.015 mg/l (<0.0016 lb/1,000 lbs) following resin adsorption. However, a pretreatment effluent of 0.00129 lb/1,000 lbs is judged achievable by upgrading the resin treatment system currently in place by installing a filter prior to the resin unit.

The BPT pesticide effluent long-term average for the priority pollutant pesticide heptachlor for direct dischargers is 0.0344 mg/l for all pesticides regulated. The BAT recommended pretreatment for pesticides is activated carbon, resin adsorption, or hydrolysis. Full-scale plant data from Plant 70 have shown that heptachlor can be reduced to 0.010 mg/l (0.00082 lb/1,000 lbs) following resin adsorption. The pretreatment effluent achievable for heptachlor is therefore 0.00082 lb/1,000 lbs (equivalent to 0.022 mg/l at the design flow for the industry) for indirect dischargers.

The BPT effluent long-term average for lindane (BHC-gamma) is 0.0344 mg/l for direct dischargers using pesticide removal. The pretreatment effluent achievable for lindane is therefore 0.0344 mg/l for indirect dischargers following the recommended pesticide removal pretreatment of activated carbon, resin adsorption, or hydrolysis. This compound is not currently manufactured and has not been monitored in the pesticide industry.

Toxaphene was previously regulated for direct discharge under 307(a) of the Act in 1977 and under BPT in 1978. The BPT effluent long-term average for toxaphene is 0.0344 mg/l using pesticide removal. The BAT

recommended pretreatment for pesticides is activated carbon, resin adsorption, or hydrolysis. At present, there are no indirect dischargers of toxaphene process wastewater; however, in the event of an indirect discharger, the recommended pretreatment long-term average is 0.0344 mg/l.

Nonconventional Pesticide Pollutants--Effluents achievable are presented below for each of the 137 pesticides to be regulated, in alphabetical order within each subcategory. Pretreatment effluents achievable are presented for nonconventional pesticides whose wastewater is currently discharged to a POTW. Both pretreatment and direct discharge effluents achievable are presented for all other nonconventional pesticides proposed for regulation.

The methodology used to estimate effluents achievable for pesticides was different from that used for priority pollutants. Because many pesticides had been regulated in BPT for direct discharge (a 0.00129 lb/1,000 lbs long-term average was utilized in BPT), current effluents at each plant were compared to the previously regulated effluent rather than to the design effluent. If current effluents achieved were greater than 0.00129 lb/1,000 lbs, then an estimated effluent achievable was calculated for direct and indirect discharge by using available treatability data for pesticide removal.

It was necessary to estimate pesticide effluents achievable on a plant-by-plant basis, because individual pesticides and not individual priority pollutants are normally found at only one plant in the industry. This approach allowed an evaluation to be made of the adequacy of pesticide analytical detection limits. The estimated pesticide effluent achievable, converted from lbs/1,000 lbs to mg/l at actual plant final discharge flow was compared to the lowest known published detection limit as follows:

1. If the estimated mg/l achievable was greater than the detection limit, then no further calculation was necessary.

2. If the estimated mg/l achievable was less than the detection limit, then it was recommended that monitoring be conducted at an in-plant, segregated stream where analytical sensitivity was sufficient to detect effluents achievable. In these cases the indirect and direct discharge effluents achievable are the same.

Subcategory 1—Atrazine is a pesticide in the triazine structural group. Plant 71, an atrazine manufacturer, uses granular activated carbon for its removal. At this plant, which discharges to a POTW, levels of 1.22 lbs/1,000 lbs are being achieved. Treatability studies by Little, et al. (1980), Lowenback (1977), Armstrong, et al. (1967), and Brown, et al. (1972) have shown that hydrolysis of atrazine is accomplished at rates similar to triazines such as cyanazine, which is being hydrolized on a full-scale basis at Plant 185 to levels which are

declared proprietary. Based on available information, it is concluded that atrazine can be treated to the same concentration as cyanazine, after the existing system at Plant 71 has been upgraded with additional hydrolysis or activated carbon, therefore a pretreatment level of 0.00803 lb/1,000 lbs is judged to be feasible.

Benomyl is one of the carbamate pesticides. Plant 72, the only manufacturer of this pesticide, uses activated carbon to treat its carbendazim carbamate wastewater. Activated carbon pretreatment effluent levels which are declared proprietary for carbendazim have been reported, but according to additional data submitted by Plant 72, subsequent activated sludge treatment will remove an additional declared proprietary percentage of the carbendazim, thereby making a final effluent of 0.000266 lb/1,000 lbs achievable. Hydrolysis of carbamates such as carbaryl, propoxur, and chlorpropram has been extensively reported by Jett (1978) as an effective alternative to treatment by activated carbon. Although no data on benomyl are currently available from the plant (a sampling program is underway), the treatability of carbamates by activated carbon or hydrolysis has been demonstrated, and it is judged that benomyl will react similarly to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim.

Busan 40 is manufactured by Plant 73, which discharges process wastewater without treatment to a POTW. Treatability studies at this plant show that hydrolysis of KN methyl, a thiocarbamate like busan 40 is, under alkaline conditions, an effective pesticide removal technique. Activated carbon is also a good alternative to treat this pesticide since metham, also a thiocarbamate, is treated by activated carbon at Plant 88, achieving POTW discharge concentrations of 0.002 mg/l (0.0000214 lb/1,000 lbs). Based on these treatability and full-scale data and the similarity of these two pesticides, it is judged that a hydrolysis system designed under conditions presented above, or an activated carbon system similar to the one currently employed by Plant 88, can achieve the detection limit of 0.05 mg/l (0.0000133 lb/1,000 lbs) for pretreatment regulations.

Busan 85 is manufactured by Plant 74, which discharges process wastewater without treatment to a POTW. Treatability studies at this plant show that hydrolysis of KN methyl, a thiocarbamate like Busan 85, is under alkaline conditions an effective pesticide removal technique. Activated carbon is also a good alternative to treat this pesticide since metham, also a thiocarbamate, is treated by activated carbon at Plant 88, achieving POTW discharge concentrations of 0.002 mg/l (0.0000214 lb/1,000 lbs). Based on these treatability and full-scale data, and the similarity of these pesticides, it is judged that a hydrolysis system designed under conditions presented above, or an activated carbon system similar to the one currently employed by Plant 88, can achieve the detection limit of 0.05 mg/l (0.0000146 lb/1,000 lbs) for pretreatment regulations.

Plant 75, the only manufacturer of carbofuran, treats this pesticide in an activated carbon unit. Pretreatment levels from activated carbon are reported to be at concentrations which are declared proprietary.

Carbam-S is manufactured by Plant 76. There are no data available on the removal of this pesticide prior to POTW discharge. Metham, a structurally similar compound, is manufactured at Plant 88, which uses activated carbon in its treatment system and reports that levels achievable for this carbamate pesticide in its direct discharge final effluent are as low as 0.002 mg/l (0.0000214 lb/1,000 lbs).

Based on this information, it is judged that an activated carbon system designed similar to that being used in Plant 88 can achieve carbam-S concentrations of 0.002 mg/l equivalent to pretreatment levels of 1.51×10^{-8} lb/1,000 lbs for Plant 76.

Coumaphos, a phosphorothioate, is manufactured by Plant 77. The plant reports that effluent levels which are declared proprietary are achievable through hydrolysis, the recommended pretreatment technology. Additional removal by hydrolysis to pretreatment levels less than 0.01 mg/l (equivalent to <0.00108 lb/1,000 lbs) is technically feasible, according to plant data, by upgrading the existing hydrolysis system (increasing the detention time from 1 hour to 2.5 hours).

According to plant data there is a declared proprietary percent removal of coumaphos through biological treatment. Therefore, based on this information, direct discharge levels achievable are judged to be the same as pretreatment levels of <0.00108 lb/1,000 lbs.

Plant 78, the only manufacturer of DBCP, reports DBCP has not been detected in the combined final effluent following hydrolysis pretreatment and biological oxidation at detection limits of 0.5 mg/l. Based on this information, Plant 78 is achieving direct discharge levels lower than 0.0462 lb/1,000 lbs. At a plant estimated flow for a segregated DBCP stream, the pretreatment level after the recommended treatment is estimated to be 0.00045 lb/1,000 lbs.

Because of the large dilution in biological treatment at Plant 78, monitoring in a segregated DBCP stream is recommended. Therefore, a direct discharge effluent level achievable will be the same as the above-mentioned pretreatment level (0.00045 lb/1,000 lbs).

Dichlorvos (DDVP) is manufactured by Plants 79, 80, and 81. Plant 80 uses hydrolysis and biological oxidation to treat its dichlorvos wastewater, which is reported to contain less than 0.01 mg/l (0.00871 lb/1,000 lbs) of pesticide in its final effluent. Although Plant 80 does not monitor pesticide levels immediately after hydrolysis pretreatment, it is estimated by plant personnel that dichlorvos levels which are declared proprietary are achieved. It is predicted that a similar hydrolysis system at Plant 81 can achieve pretreatment levels equivalent to 0.01 mg/l (0.0002 lb/1,000 lbs). Plant 79, which contract hauls its process wastewater after pretreatment by neutralization,

stripping, and metal separation, reports pretreated effluent levels of <0.1 mg/l (equivalent to <0.00574 lb/1,000 lbs).

Dinoseb (DNBP) is manufactured by Plant 82, which reports a removal of DNBP greater than a declared proprietary percentage through its tertiary activated carbon treatment system to effluent levels less than 0.92 mg/l (<0.555 lb/1,000 lbs). Hood (1979) reported pilot plant data from studies of DNBP which showed a removal of a declared proprietary percentage achievable by activated carbon pretreatment to levels of 0.0676 lb/1,000 lbs.

Based on a declared proprietary percent removal which is achievable through tertiary carbon, the pretreatment effluent can be further reduced to a detection limit of 0.01 mg/l, and a direct discharge effluent level of 0.0061 lb/1,000 lbs will be achievable.

The only manufacturer of dioxathion, Plant 83, uses hydrolysis to reduce the pesticide by a percentage which is declared proprietary to a concentration which is declared proprietary. Since dioxathion, a phosphorodithioate, is structurally similar to parathion (which is hydrolyzed by a declared proprietary percentage at Plant 161) a similar reduction to 0.72 mg/l (0.00751 lb/1,000 lbs) for a pretreatment effluent is judged to be achievable.

Because of the large amount of dilution in the biological treatment at this plant, the direct discharge effluent is estimated to be the same as the pretreatment effluent.

Ferbam is manufactured by Plant 84, which uses evaporation/crystallization prior to POTW discharge to treat ferbam process wastewater. Other thiocarbamate pesticides like ferbam are being successfully treated by activated carbon on a full-scale basis (e.g., metham in Plant 88). Based on this information it is judged that if the wastewaters from the ferbam process are treated by an activated carbon system similar to the system currently employed by Plant 88, POTW discharge levels of 0.05 mg/l (detection limit for dithiocarbamates, ESE and EPA Method 630) equivalent to 0.0027 lb/1,000 lbs are technically feasible.

Isopropalin, a nitro pesticide, is manufactured only by Plant 85, which incinerates its wastewater and discharges scrubber effluent to the tertiary treatment system. Pesticide data from this scrubber effluent are not available. Other pesticides with structures similar to isopropalin have been demonstrated on full and pilot-scale basis to be treatable by activated carbon. Trifluralin, a nitro pesticide, is being treated by activated carbon in Plant 85, and effluent pretreatment levels which are declared proprietary have been reported. Based on structural similarities of isopropalin and trifluralin, it is judged that an activated carbon system will reduce isopropalin to the same concentrations and a pretreatment level of 0.00123 lb/1,000 lbs is judged to be achievable.

There is an apparent increase in pesticide levels at the direct discharge of Plant 85 due to the lack of analytical sensitivity at greatly diluted flows. It is concluded, therefore, that direct discharge and pretreatment levels of 0.00123 lb/1,000 lbs are achievable.

KN methyl is manufactured by Plant 86, which discharges process wastewater without treatment to a POTW. Treatability studies at this plant show that hydrolysis of KN methyl is, under alkaline conditions, an effective pesticide removal technique. Activated carbon is also a good alternative to treat this pesticide since metham, a thiocarbamate like KN methyl, is treated by activated carbon at Plant 88, achieving POTW discharge concentrations of 0.002 mg/l (0.0000214 lb/1,000 lbs). Based on these treatability and full-scale data and the similarity of these two pesticides, it is judged that a hydrolysis system designed under conditions presented above, or an activated carbon system similar to the one currently employed by Plant 88, can achieve the detection limit of 0.05 mg/l (0.0000077 lb/1,000 lbs) for pretreatment regulations.

Metham is manufactured by Plants 87 and 88. Plant 88, which uses activated carbon in its treatment system, reports that levels achievable for this carbamate pesticide in its direct discharge final effluent are as low as 0.002 mg/l (0.0000214 lb/1,000 lbs).

Based on this information, it is judged that an activated carbon system designed similar to that being used in Plant 88 can achieve metham concentrations of 0.002 mg/l equivalent to pretreatment levels of 0.00002 lb/1,000 lbs for Plant 87.

Mevinphos is manufactured by Plants 89 and 90. Plant 89 uses hydrolysis and biological oxidation and reports no mevinphos detected at limits of 0.1 mg/l in the final effluent. Based on this information, Plant 89 is achieving direct discharge levels less than 0.026 lb/1,000 lbs. At a plant estimated flow for a segregated stream the pretreatment level after the recommended treatment is 0.00105 lb/1,000 lbs. For Plant 90, it is judged that a similar hydrolysis treatment system will achieve POTW discharge levels of 0.00296 lb/1,000 lbs. Because of the large dilution in the biological treatment at Plant 89, monitoring in a segregated mevinphos stream is recommended and a direct discharge effluent level achievable therefore will be the same as the abovementioned pretreatment level (0.0015 lb/1,000 lbs).

Plant 91, the only manufacturer of niacide, produces this pesticide only 10 days per year. Niacide, which is a metallo-organic pesticide, is treated in this plant by evaporation and crystallization prior to discharge to a POTW. Monitoring of the evaporator discharge (condensate) has shown levels of similar metallo-organics, such as zineb, to be 0.35 mg/l (0.0213 lb/1,000 lbs).

The reduction of maneb, another metallo-organic pesticide like niacide, by activated carbon to a level less than 0.15 mg/l was reported by

Little, et al. (1980). Based on these data, the reduction of niacide by activated carbon to a pretreatment level of 0.15 mg/l (0.0302 lb/1,000 lbs) in comingled pesticide streams is judged to be technically feasible.

Oxamyl is manufactured only by Plant 92. No data on the removal of this pesticide through biological oxidation are available from the plant. Pesticides with structures similar to oxamyl, such as methomyl, are being treated at Plant 136 through chemical oxidation and biological treatment. Removal of methomyl has been reported to be a declared proprietary percentage through chemical oxidation and a declared proprietary percentage by biological oxidation. Based on these data and the similarity of these two pesticides, it is judged that oxamyl can be similarly removed by these treatment technologies to the same level as methomyl. Therefore, concentrations of <0.01 mg/l (0.0084 lb/1,000 lbs) for direct discharge and 0.1 mg/l (0.0872 lb/1,000 lbs) for pretreatment are judged to be achievable for oxamyl.

PCP salt is manufactured by Plant 93, which treats its wastewater by a series of units including skimming, flocculation, and sludge thickening. No treated effluent data are available from the plant. PCNB, a halogenated aromatic pesticide structurally similar to PCP salt, is being treated by activated carbon at Plant 179 to levels which are declared proprietary. Based on this information, it is judged that PCP salt can be successfully treated by activated carbon to detection limits of 0.05 mg/l (EPA Method 625 for pentachlorophenol) to achieve pretreatment levels of 0.000376 lb/1,000 lbs.

Phorate is manufactured by Plant 94. Plant 95 ceased production of this pesticide. Plant 94 employs hydrolysis in the treatment of its wastewater. Final treated effluent data for this pesticide are not available from the plant, although a declared proprietary percent removal through hydrolysis has been reported, achieving concentrations which are declared proprietary. Diazinon and parathion, also phosphorothioate pesticides like phorate, are being treated on full-scale basis by hydrolysis at Plants 172 and 161, respectively, and effluent concentrations for this pesticide after hydrolysis are declared to be proprietary for diazinon and parathion. Based on plant data, additional hydrolysis of phorate from a declared proprietary level to 0.01 mg/l is achievable by increasing the detention time from 1 hour to 2 hours. It is predicted that this additional hydrolysis will reduce phorate to pretreatment and direct discharge effluent levels equivalent to those achievable for fensulfothion, also a phosphorothioate. Because of the large dilution in the final effluent, pretreatment and direct discharge achievable effluent levels for fensulfothion are the same--0.00167 lb/1,000 lbs.

Terbacil, manufactured only by Plant 96, is in the uracil structural group along with bromacil. Terbacil data available from the plant showed a declared proprietary percent removal of terbacil in a comingled waste stream by chemical oxidation, compared to the declared proprietary percent removal of bromacil through the same system. Based on these

proprietary data and the structural similarity of these two pesticides, it is predicted the removal of terbacil by chemical oxidation and biological treatment will achieve levels equivalent to those for bromacil of 0.0261 lb/1,000 lbs for direct discharge and 0.149 lb/1,000 lbs for pretreatment.

The phosphorothioate pesticide terbufos is manufactured by Plants 97 and 98. Plant 97, which direct discharges its wastewater without treatment, reports final effluent levels of 4,320 mg/l (4.0 lbs/1,000 lbs) for terbufos. Plant 98 disposes its wastewater by incineration, which generates a scrubber effluent that is treated by chemical oxidation and biological treatment prior to direct discharge. No data are available from the plant on the incinerator or final effluent pesticide content. In general, incineration has been demonstrated to achieve nearly complete destruction of pesticides. Hydrolysis has also been extensively reported (Jett, 1978) to be an effective treatment for the removal of phosphorothioates. It is predicted that through hydrolysis, detection limits of 0.001 mg/l (equivalent to 0.000013 lb/1,000 lbs) at Plant 98 and 1.0 mg/l (0.000926 lb/1,000 lbs) at Plant 97 can be achieved for pretreatment regulations.

Because of the large dilution in the final effluent of these plants, direct discharge levels achievable are the same as pretreatment levels.

Tricyclazole is manufactured by Plant 99, which treats its wastewater by thermal oxidation. The incinerator scrubber effluent is further treated by aerated lagoon and multimedia filtration prior to disposal to navigable waters. No data are available from the plant to determine the effluent levels of this pesticide in the scrubber discharge, although the plant has estimated that the scrubber effluent pesticide discharge is less than the BPT level of 0.00129 lb/1,000 lbs long-term average.

Based on data presented in this document for the pesticide industry, a 50 percent removal of tricyclazole by biological treatment is predicted. A direct discharge level of 0.00129 lb/1,000 lbs is predicted to be achievable after the pesticide removal in the biological system; therefore, pretreatment levels of 0.00258 lb/1,000 lbs are judged to be feasible.

Subcategory 2—Alachlor is manufactured by Plants 100 and 101. Plant 100, which treats its wastewater by gravity separation prior to POTW discharge, reports alachlor raw waste load data of a concentration which is declared proprietary. Plant 101 treats alachlor wastewater by biological oxidation, achieving effluent levels of 10.3 mg/l (0.556 lb/1,000 lbs)--a declared proprietary percent removal.

Propachlor, an amide pesticide like alachlor, is removed by activated carbon in Plant 140 up to a declared proprietary percentage. Also, studies done by Arthur D. Little, Inc. (1979) showed that activated carbon removed 99.8 percent of alachlor. Based on these data it is predicted that an activated carbon system will achieve pretreatment effluent levels of 0.0938 lb/1,000 lbs in Plant 100 and of 0.00142 lb/1,000 lbs in Plant 101.

Based on Plant 101 data, additional treatment by biological oxidation will achieve direct discharge levels of 0.00112 lb/1,000 lbs at Plant 101.

AOP is manufactured by Plant 102 which uses evaporation/crystallization prior to POTW discharge. Effluent levels for AOP of 0.35 mg/l (0.0213 lb/1,000 lbs) in comingled pesticide streams have been reported by the plant. Other thiocarbamate pesticides like AOP are being successfully treated by activated carbon on a full-scale basis (e.g., metham in Plant 88). Based on this information, it is judged that if the wastewater from the AOP process combined with other dithiocarbamates process wastewaters is treated by an activated carbon system similar to the system currently employed by Plant 88, POTW discharge levels of 0.05 mg/l (detection limit for dithiocarbamates, ESE and EPA Method 630) equivalent to 0.0037 lb/1,000 lbs are technically feasible.

Plant 103, the only manufacturer of benfluralin, uses activated carbon to treat process wastewater. No data are available from the plant on removal; however, this pesticide has a structure similar to other nitro pesticides like trifluralin, which is treated at Plant 103 by activated carbon to levels which are declared proprietary. It is judged then, based on the similarity of these two pesticides, that the reduction of benfluralin to pretreatment levels of 0.00123 lb/1,000 lbs is technically feasible.

There is an apparent increase in pesticide levels at the direct discharge of Plant 103, due to the lack of analytical sensitivity at greatly diluted flows. It is concluded, therefore, that direct discharge and pretreatment levels of 0.00123 lb/1,000 lbs are achievable.

Bentazon is manufactured only by Plant 104. Process wastewater is treated by activated carbon, chemical oxidation, and biological treatment after it is combined with the remainder of plant wastewater. Available plant data show an estimated bentazon direct discharge effluent level of 0.09 mg/l (0.0054 lb/1,000 lbs), based on the plant permit application. It is therefore predicted that direct discharge levels of 0.0054 lb/1,000 lbs are achievable.

Based on data presented in this document for the pesticide industry, a 50 percent removal of bentazon by biological treatment is predicted. A direct discharge level of 0.0054 lb/1,000 lbs is predicted to be achievable after the pesticide removal in the biological system; therefore pretreatment levels of 0.0108 lb/1,000 lbs are judged to be feasible.

Plant 105, the only manufacturer of bolstar, has demonstrated a declared proprietary percent removal using hydrolysis as treatment. Diazinon and parathion, also phosphorothioate pesticides like Bolstar, are being treated on full-scale basis by hydrolysis at Plants 172 and 161, respectively. Pretreatment effluent levels which are declared proprietary for diazinon and parathion methyl are being achieved.

Based on plant data, additional hydrolysis of bolstar from approximately a declared proprietary value to 0.03 mg/l is achievable by increasing detention time (8 hours detention versus the current 4 hours) and pretreatment levels of 0.00112 lb/1,000 lbs (assuming average flow for the pesticide industry) will be feasible.

Because of the large amount of dilution in the biological treatment system of Plant 105, the direct discharge effluent achievable is estimated to be the same as the pretreatment achievable effluent, and it is recommended that monitoring be conducted in segregated wastewater after pretreatment.

The uracil pesticide, bromacil, is produced only by Plant 106. The raw waste load for bromacil has been reported by the plant to be a declared proprietary value. The effluent achieved following biological treatment was reported to be 3.2 mg/l (equivalent to 3.71 lbs/1,000 lbs). The same plant also reported that a declared proprietary percent removal of this pesticide is achievable through chemical oxidation (chlorination) of a separate waste stream. It is judged that if a similar chlorination system were used to pretreat the bromacil raw waste load, the achievement of pretreatment levels of 0.149 lb/1,000 lbs (0.14 mg/l) is technically feasible. The degradation of bromacil by sulfuric acid was reported by Kennedy, et al. (1969), who reported a complete structural change of bromacil with the addition of the acid. The study does not present removal data, but it clearly stated that the treatment of bromacil by this method is a successful treatment alternative.

Plant 106 reports a declared proprietary percent removal of bromacil through biological oxidation. Based on these proprietary data, a concentration of 0.0261 lb/1,000 lbs is judged to be achievable for direct discharge.

Butachlor is manufactured by Plant 107, which treats butachlor wastewater by biological oxidation, achieving effluent levels of 2.08 mg/l (1.34 lbs/1,000 lbs)--a declared proprietary percent removal.

Propachlor, an amide pesticide like butachlor, is removed by activated carbon in Plant 140 up to a declared proprietary percentage. Studies done by Arthur D. Little, Inc. (1979) showed that activated carbon removed 99.8 percent of alachlor, also an amide pesticide. Based on these data it is predicted that an activated carbon system will achieve pretreatment effluent levels of 0.00548 lb/1,000 lbs for butachlor.

Based on plant data, additional treatment by biological oxidation will achieve direct discharge levels of 0.00268 lb/1,000 lbs.

The carbamate pesticide, carbendazim, is manufactured by Plant 108. The activated carbon system in this plant achieves up to a declared proprietary percent removal of this pesticide with pretreatment effluent levels which are declared proprietary.

Additional data provided by Plant 108 show subsequent removal of carbendazim up to a declared proprietary percentage by activated sludge. Based on these proprietary data, it can be predicted that an activated carbon/activated sludge combination system will technically achieve a direct discharge effluent level of 0.000266 lb/1,000 lbs for carbendazim.

Carbophenothion is manufactured by Plant 109, which contract hauls portions of its wastewater and evaporates the remainder. Carbophenothion, a phosphorodithioate, will hydrolyze under conditions and rates (Jett, 1978) equivalent to those for parathion at Plant 161. Effluent levels of parathion methyl after hydrolysis have been reported by Plant 161, and are declared to be proprietary values. Based on these data and the structural similarity of carbophenothion and parathion, it is judged that a hydrolysis treatment system will reduce carbophenothion to the same concentrations and a pretreatment effluent level of 0.0000229 lb/1,000 lbs will be feasible.

Chlorobenzilate, a DDT-type pesticide, is manufactured by Plants 110 and 111. Plant 110 reports treated effluent levels of <0.554 mg/l (<0.0827 lb/1,000 lbs) after biological treatment. No data are available from Plant 111 to show removal of this pesticide through chemical oxidation.

Literature studies (Love, 1977; Whitehouse, 1967; Eichelberger, 1971; and Hager, 1976) have extensively reported up to 95 to 99 percent removal of DDT, methoxychlor, and other DDT-type pesticides by activated carbon. Treatment of chlorobenzilate by this technology is predicted to remove the pesticide to the detection limit (0.25 mg/l). Therefore, a pretreatment effluent of 0.0124 lb/1,000 lbs in Plant 110 is achievable.

Additional data provided by Plant 110 show removal of chlorobenzilate up to a declared proprietary percentage by biological treatment. Based on these data it is predicted that an activated carbon/biological treatment combination system will technically achieve direct discharge effluent levels of 0.00112 lb/1,000 lbs at Plant 110.

Chlorpyrifos, a phosphorothioate, is manufactured by Plant 111. Wastewater from this process is disposed by deep well injection. No raw waste or treated effluent data are available from the plant. Hydrolysis has been proven on a full-scale basis to be successful in removing pesticides in the phosphorothioate and phosphorodithioate group. For example, parathion and diazinon are removed by hydrolysis in Plants 161 and 172, respectively, to concentrations which are declared proprietary. Based on the structural similarity of these pesticides with chlorpyrifos, it is predicted that a hydrolysis system will remove this pesticide to equivalent concentrations, and pretreatment levels of 0.00104 lb/1,000 lbs in Plant 111 will be feasible.

Because of the large amount of dilution in the biological treatment of this plant, the direct discharge effluent achievable at this plant is estimated to be the same as the pretreatment effluent.

Chlorpyrifos methyl, a phosphorothioate, is manufactured by Plant 112. Wastewater from this process is disposed by deep well injection. No raw waste or treated effluent data are available from the plant. Hydrolysis has been proven on a full-scale basis to be successful in removing pesticides in the phosphorothioate and phosphorodithioate group. For example, parathion and diazinon are removed by hydrolysis in Plants 161 and 172, respectively, to concentrations which are declared proprietary. Based on the structural similarity of these pesticides with chlorpyrifos methyl, it is predicted that a hydrolysis system will remove this pesticide to equivalent concentrations, and pretreatment levels of 0.00104 lb/1,000 lbs in Plant 112 will be feasible.

Because of the large amount of dilution in the biological system of this plant, the direct discharge effluent limitation achievable at this plant is therefore estimated to be the same as the above-mentioned pretreatment level.

Plant 169, the only manufacturer of 2,4-D isobutyl ester, uses activated carbon to pretreat the wastewater from this pesticide process prior to POTW discharge. Final effluent levels of 0.0359 mg/l have been reported for the acid, and it is predicted that equivalent levels will be achievable for this ester. Therefore, POTW discharge levels of 0.00105 lb/1,000 lbs are achievable.

2,4-D isooctyl ester is manufactured by Plant 170. This plant uses activated carbon to pretreat the wastewater from this pesticide process prior to POTW discharge. Final effluent levels of 0.0359 mg/l have been recently reported for the acid, and it is predicted that equivalent levels will be achievable for this ester. Therefore, POTW discharge levels of 0.00105 lb/1,000 lbs are achievable.

Plant 113, the only manufacturer of 2,4-DB, uses activated carbon to treat the wastewater from this pesticide process prior to POTW discharge. Final effluent levels after treatment are reported to be <0.0084 mg/l (<0.00102 lb/1,000lbs). Additional sampling is being conducted at this plant to determine exact effluents achievable.

Plant 114, the only manufacturer of 2,4-DB isobutyl ester, uses activated carbon to treat the wastewater from this pesticide process prior to POTW discharge. Data are not available from the plant to show final effluent levels after treatment by activated carbon. 2,4-DB is currently being removed to final effluent levels of <0.0084 mg/l (<0.00102 lb/
1,000 lbs).

Based on these data and the structural similarity of these two pesticides, it is judged that POTW discharge levels for 2,4-DB isobutyl ester will be equivalent to those achievable for 2,4-DB. Additional sampling is being conducted at this plant to determine exact effluents achievable.

Plant 115, the only manufacturer of 2,4-DB isooctyl ester, uses activated carbon to treat the wastewater from this pesticide process

prior to POTW discharge. Data are not available from the plant to show final effluent levels after treatment by activated carbon. 2,4-DB is currently being removed to final effluent levels of <0.0084 mg/l (<0.00102 lb/1,000 lbs).

Based on these data and the structural similarity of these two pesticides, it is judged that POTW discharge levels for 2,4-DB isooctyl ester will be equivalent to those achievable for 2,4-DB. Additional sampling is being conducted at this plant to determine exact effluents achievable.

Plants 116 and 117 are the manufacturers of deet. Plant 116 reports a declared proprietary percent removal of this pesticide by activated carbon to pretreatment levels which are declared proprietary. Plant 117 treats this pesticide by chemical oxidation prior to POTW discharge but data on removal are not available. It is predicted that an activated carbon system similar to that in Plant 116 will achieve pretreatment levels of 1.26 mg/l (0.00158 lb/1,000 lbs) in Plant 117.

Because of the large amount of dilution in the biological treatment systems of Plant 116, the direct discharge effluent achievable is therefore estimated to be the same as the pretreatment level of 1.26 mg/l (0.031 lb/1,000 lbs) judged to be achievable.

Demeton, a phosphorothioate, is manufactured by Plant 118. The plant reports that effluent levels which are declared proprietary are achievable through hydrolysis, the recommended pretreatment technology. Additional removal by hydrolysis to pretreatment levels less than 0.01 mg/l (equivalent to 0.00062 lb/1,000 lbs) is technically feasible, according to plant data, by upgrading the existing hydrolysis system (increasing the detention time from 5 hours to 10 hours).

According to plant data, there is a declared proprietary percent removal of demeton through biological treatment. Based on these proprietary data, the direct discharge levels achievable will be the same as pretreatment levels--0.00062 lb/1,000 lbs.

The only manufacturer of dichlofenthion is Plant 119, which disposes the wastewater from this pesticide process by deep well injection with no pretreatment. Raw wasteload concentrations of this pesticide have been reported, and are declared to be proprietary. Hydrolysis is known to be an effective treatment for phosphorothioates like dichlofenthion, to reach levels which are declared proprietary (e.g., diazinon in Plant 172 and parathion methyl in Plant 161). It is predicted that similar hydrolysis systems can reduce dichlofenthion to equivalent pretreatment levels resulting in a pretreatment achievable value of 0.05 mg/l (0.0000809 lb/1,000 lbs).

Dichlorobenzene, ortho (1,2-dichlorobenzene) is manufactured by Plants 120, 121, 122, and 123. Plant 121 reports a declared proprietary percent removal of this pesticide through biological treatment. These data result from combined dichlorobenzenes (ortho, meta, and para) in comingled waste streams. Plant 120, which uses gravity separation and

neutralization as treatment, reports a final effluent concentration for total chlorobenzenes < 0.081 mg/l (0.09 lb/1,000 lbs). No data for Plants 122 and 123 are available. Other halogenated aromatic pesticides like dichlorobenzene, ortho are being treated on a full-scale basis by activated carbon. PCNB, which is a pesticide with structures similar to dichlorobenzene, ortho, is treated by activated carbon at Plant 179 to effluent levels which are declared proprietary--a declared proprietary percent removal. Based on these data it is predicted that pretreatment of dichlorobenzene, ortho with activated carbon and additional treatment by biological oxidation will achieve direct discharge levels of 0.0000765 lb/1,000 lbs.

Dichlorobenzene, para (1,4-dichlorobenzene) is manufactured by Plants 124, 125, 126, and 127. Plant 125 reports a declared proprietary percent removal of this pesticide through biological treatment. These data result from combined dichlorobenzenes (ortho, meta, and para) in comingled waste streams. Plant 124, which uses gravity separation and neutralization as treatment, reports final effluent concentration for total chlorobenzenes <0.081 mg/l (0.09 lb/1,000 lbs). No data are available for Plants 126 and 127. Other halogenated aromatic pesticides like dichlorobenzene, para are being treated on a full-scale basis by activated carbon. PCNB, which is a pesticide with structures similar to dichlorobenzene, para, is treated by activated carbon at Plant 179 to effluent levels which are declared proprietary--a declared proprietary percent removal. Based on these data it is predicted that pretreatment of dichlorobenzene, para with activated carbon and additional treatment by biological oxidation will achieve direct discharge levels of 0.0000765 lb/1,000 lbs.

Plant 128, the only manufacturer of ethalfluralin, uses activated carbon to treat process wastewater. No data are available from the plant on removal; however, this pesticide has a structure similar to other nitro pesticides like trifluralin, which is treated at Plant 128 by activated carbon to levels which are declared proprietary. It is judged, then, based on the similarity of these two pesticides, that the reduction of ethalfluralin to pretreatment levels of 0.00123 lb/1,000 lbs is technically feasible. There is an apparent increase in pesticide levels at the direct discharge of Plant 128, due to the lack of analytical sensitivity at greatly diluted flows. It is concluded, therefore, that direct discharge and pretreatment levels of 0.00123 lb/1,000 lbs are achievable.

Plant 129, the only manufacturer of ethion, reports an average raw waste load which is declared proprietary for ethion prior to discharge to a POTW. This pesticide is in the phosphorodithioate structural group. The effectiveness of hydrolysis on pesticides with structures similar to ethion has been extensively reported (Jett, 1978). It is therefore predicted that a hydrolysis system at Plant 129 can remove ethion to nondetectable concentrations of 0.001 mg/l (EPA Method 614), and pretreatment levels of 0.000138 lb/1,000 lbs can be achievable.

Because of the large dilution in the combined discharge of this plant, direct discharge levels achievable are estimated to be the same as pretreatment levels.

The only manufacturer of etridiazole, Plant 130, uses activated carbon to treat this pesticide wastewater. No data are available from the plant to show how much etridiazole is removed by the activated carbon system, since the product has been temporarily discontinued. Isotherm data used in the activated carbon column design showed that etridiazole and PCNB were similarly treatable; therefore, direct discharge levels judged to be achievable for PCNB of 0.0182 mg/l (0.0000765 lb/1,000 lbs) are also judged to be achievable for etridiazole.

Fenthion, a phosphorothioate, is manufactured by Plant 131. The plant reports that effluent levels which are declared proprietary are achievable through hydrolysis, the recommended pretreatment technology. Additional removal by hydrolysis to pretreatment levels less than 0.01 mg/l (equivalent to 0.0006 lb/1,000 lbs) is technically feasible, according to plant data, by upgrading the existing hydrolysis system (increasing the detention time from 1 hour to 2.5 hours).

Data from Plant 131 show that an additional declared proprietary percentage of the pesticide is removed via biological oxidation; therefore, it is judged that a direct discharge effluent of 0.0003 lb/1,000 lbs is achievable.

The only manufacturer of glyphosate, Plant 132, treats this pesticide wastewater by biological oxidation. Literature information for other pesticides in the phosphorus-nitrogen pesticide shows hydrolysis to be feasible in alkali or acid conditions (2> pH >9). It is judged that treatment by a hydrolysis system, similar to that presented in this document, can remove glyphosate to an achievable effluent of 1.0 mg/l, and an achievable pretreatment level of 0.0676 lb/1,000 lbs at Plant 132.

According to plant data, a declared proprietary percentage of the glyphosate is removed via biological oxidation. Based on these data, the direct discharge effluent achievable at final plant flow is judged to be 0.00703 lb/1,000 lbs.

Hexazinone, a triazine pesticide, is manufactured only by Plant 133, which incinerates hexazinone process wastewater and treats the incinerator scrubber effluent by biological oxidation. Plant data show a declared proprietary percent removal of the pesticide through biological treatment. Hydrolysis and activated carbon have been proven on a full-scale basis to be successful in removing triazines to levels of 1 mg/l.

Based on these data, it is judged that an activated carbon or hydrolysis system similar to that presented in this document can achieve a pretreatment effluent of 1 mg/l (0.00606 lb/1,000 lbs). Based on plant data presented above, additional removal of hexazinone by biological

oxidation after pretreatment is predicted to achieve direct discharge levels of 0.000551 lb/1,000 lbs.

Mephosfolan is manufactured by Plant 134, which ocean discharges its wastewater without treatment. Data from the plant show mephosfolan discharge levels of 1,630 mg/l (17.9 lbs/1,000 lbs). This phosphorus-nitrogen pesticide, according to plant personnel, will hydrolyze easily. It is therefore predicted that hydrolysis pretreatment effluent of 1.0 mg/l (0.011 lb/1,000 lbs) is achievable.

Because of the large dilution in the combined discharge at this plant, direct discharge levels achievable are the same as pretreatment levels.

Methomyl is an amide-type pesticide manufactured by Plants 135, 136, and 137, none of which has the recommended pesticide removal treatment. Plant 136, which uses chemical oxidation to treat portions of its methomyl wastewater, reports up to a declared proprietary percent removal of this pesticide through chemical oxidation. Pretreatment levels of 0.0872 lb/1,000 lbs are judged to be technically feasible in Plant 136 if all portions of the methomyl wastewater are pretreated by chemical oxidation.

Plant 136 also reports up to a declared proprietary percent removal of methomyl through biological oxidation. It is judged that pretreatment by chemical oxidation followed by biological oxidation will achieve nondetectable concentrations (< 0.01 mg/l) in the final discharge equal to 0.0084 lb/1,000 lbs.

It is also predicted that a chemical oxidation/biological treatment combination system at Plants 135 and 137 will achieve equivalent effluent levels to those achievable by Plant 136.

Naled is manufactured by Plant 138, which uses hydrolysis and biological oxidation to treat the wastewater to less than 0.1 mg/l (0.061 lb/1,000 lbs) of pesticide in its combined final effluent. Although Plant 138 does not monitor pesticide levels immediately after hydrolysis pretreatment, it is estimated by plant personnel that naled pretreatment levels which are declared proprietary are achieved. Because of the large dilution in the combined discharge at this plant, it is recommended that monitoring be conducted in segregated wastewater after pretreatment. Therefore, the recommended pretreatment and direct discharge achievable values are the same--0.1 mg/l (0.00069 lb/1,000 lbs).

Profluralin, a nitro pesticide, is manufactured by Plant 139. This plant has reported effluent levels of less than 1.62 mg/l (<1.05 lbs/1,000 lbs) of profluralin when treated by biological oxidation (aerated lagoons). Pesticides with structures similar to profluralin have been reported to be treatable by activated carbon. Trifluralin is treated in a full-scale activated carbon system (Plant 162) to effluent levels which are declared proprietary. Based on these data and the structural similarity of these pesticides, it is expected that profluralin, if pretreated by activated carbon, can achieve pretreatment levels of 0.13 lb/1,000 lbs.

Data from Plant 139 show an additional declared proprietary percent of the pesticide is removed via biological oxidation. Based on these data, the the estimated direct discharge effluent achievable is 0.0525 lb/ 1,000 lbs.

Propachlor, an amide pesticide, is manufactured by Plants 140 and 141. Plant 140 uses activated carbon for pretreatment and reports effluent concentrations which are declared proprietary--a declared proprietary percent removal. Biological treatment at Plant 141 removes this pesticide to effluent levels of 0.012 mg/l (0.0029 lb/1,000 lbs)--a declared proprietary percent removal.

No data are available for Plant 140 to show the extent of propachlor removal through biological treatment. Based on data from Plant 140 it is predicted that 99.9 percent additional pretreatment of propachlor by activated carbon at Plant 141 can achieve pretreatment effluent levels of 0.0069 lb/1,000 lbs.

Due to the large amount of dilution in biological systems at these two plants, the direct discharge effluent achievable is estimated to be the same as the pretreatment effluent, and it is recommended that monitoring be conducted in segregated wastewater after pretreatment.

Ronnel, a phosphorothioate, is manufactured by Plant 142. Wastewater from this process is disposed by deep well injection. No raw waste or treated effluent data are available from the plant. Hydrolysis has been proven on a full-scale basis to be successful in removing pesticides in the phosphorothioate and phosphorodithioate group. For example, parathion and diazinon are removed by hydrolysis in Plants 161 and 172, respectively, to concentrations which are declared proprietary. Based on the structural similarity of these pesticides to ronnel, it is predicted that a hydrolysis system will remove this pesticide to equivalent concentrations, and pretreatment levels of 0.00047 lb/1,000 lbs in Plant 142 will be feasible.

Because of the large amount of dilution in the biological treatment of this plant, direct discharge effluent is estimated to be the same as the pretreatment effluent, and it is recommended that monitoring be conducted in segregated wastewater after pretreatment.

Stirofos is a phosphate pesticide manufactured by Plant 143, where hydrolysis and biological oxidation are utilized. The plant reports that no stirofos has been detected over 0.01 mg/l in the final effluent. Based on this information, Plant 143 is achieving direct discharge levels lower than 0.0026 lb/1,000 lbs.

Based on data presented in this document for the pesticide industry, a 50 percent removal of stirofos by biological treatment is predicted. A direct discharge level of 0.0026 lb/1,000 lbs is predicted to be achievable after the pesticide removal in the biological system; therefore pretreatment levels of 0.0052 lb/1,000 lbs are judged to be feasible.

Triadimefon, an organo-nitrogen pesticide, is manufactured by Plant 144; however, effluent levels are not available from the plant. Some plants producing similarly-structured pesticides generate no wastewater. Final effluent levels of lethane 384, also an organo-nitrogen, have been reported at less than 0.00183 mg/l (0.00392 lb/1,000 lbs) after biological treatment. Because of the presence of amino subtituents in most of the pesticides in this group, hydrolysis is predicted to be the most feasible technology for their degradation. Based on data from lethane 384, an effluent of 0.00392 lb/1,000 lbs is also predicted to be achievable for triademefon at Plant 144.

Trichlorobenzene (TCB), specifically 1,2,4-trichlorobenzene, is manufactured by Plant 145, which treats its TCB wastewater by biological oxidation. Plant data show concentrations of TCB in the influent to biological treatment, and are declared proprietary values. Activated carbon has been demonstrated to remove halogenated aromatic pesticides on a full-scale basis. Effluent levels for PCNB at Plant 179, where activated carbon is used for treatment, are reported and are declared to be proprietary--a declared proprietary percent removal of the pesticide. Based on these data and the structural similarities of these two compounds (TCB and PCNB), it is predicted that an activated carbon system similar to the one employed by Plant 179 will achieve an equivalent removal of the pesticide, and pretreatment effluent levels 0.0036 mg/l (0.00018 lb/1,000 lbs) will be feasible.

Although no data describing the extent of TCB removal through biological treatment are available from Plant 145, the plant reports that removal of a declared proprietary percentage or greater is being achieved for other halogenated aromatic pesticides. Based on this, it is judged that direct discharge levels of 0.0036 mg/l (0.00018 lb/1,000 lbs) are technically feasible.

Trichloronate is manufactured by Plant 146, which uses steam stripping, activated carbon, and biological oxidation to treat trichloronate process wastewater prior to discharge to a navigable waterway. Although no pretreatment data are available to demonstrate the efficiency of the steam stripping or activated carbon units, trichloronate final effluent levels in a comingled waste stream have been reported to be 0.0143 mg/l (0.0642 lb/1,000 lbs).

Plant data for similar phosphorothioate pesticides show pesticide removal by hydrolysis to pretreatment levels less than 0.01 mg/l (0.0444 lb/1,000 lbs). Data from Plant 146 also show removal of trichloronate through biological oxidation at a declared proprietary percentage. Therefore, if the treatment system at Plant 146 was upgraded to effect an additional declared proprietary percent pollutant removal, the theoretical direct discharge effluent achievable based on the above-mentioned pretreatment level of 0.01 mg/l is 0.0040 lb/1,000 lbs following pretreatment and biological oxidation.

Subcategory 3--Mancozeb, manufactured by Plant 147, is one of the similarly-structured compounds known as metallo-organics. Little, et al. (1980) reported the reduction of maneb, another metallo-organic

pesticide, by activated carbon to a level less than 0.15 mg/l. Based on these data and the similarity of these two pesticides, the reduction of mancozeb by activated carbon to the equivalent level of 0.15 mg/l (0.0125 lb/1,000 lbs) is judged to be technically feasible for pretreatment.

Maneb is manufactured by Plants 148 and 149. Little, et al. (1980) reported the treatment of this pesticide to levels less than 0.15 mg/l by activated carbon. Based on these data, it is judged that levels of 0.15 mg/l (0.00473 lb/1,000 lbs) at Plant 148 and 0.15 mg/l (0.0125 lb/1,000 lbs) at Plant 149 are technically feasible for pretreatment. A metal separation unit (once used by Plant 148) is an alternative treatment to remove pesticides and heavy metals like zinc and manganese present in the wastewater.

Little, et al. (1980) also reported the reduction of 50 percent of maneb by biological treatment. Because of the large amount of dilution in the biological treatment of Plant 148, maneb concentrations in the final effluent would not be detectable (<0.05 mg/l), therefore by monitoring in a segregated stream, pretreatment achievable value of 0.00473 lb/1,000 lbs would be feasible.

Zineb is manufactured by Plant 150. No data for this pesticide are available from this plant. Little, et al. (1980) reported the reduction of maneb, a metallo-organic pesticide like zineb, by activated carbon to levels less than 0.15 mg/l. Based on these data and the similarity of these two pesticides, the reduction of zineb by activated carbon to the equivalent pretreatment level of 0.15 mg/l (0.0077 lb/1,000 lbs) in Plant 150 is judged to be technically feasible.

Ziram is manufactured by Plants 151 and 152. Plant 152 uses biological oxidation to treat the wastewater, but removal data are not available. Monitoring of the evaporator discharge (condensate) at Plant 156 has shown levels of zineb to be 0.35 mg/l (0.0213 lb/1,000 lbs) before discharge to a POTW. Little, et al. (1980) reported the reduction of maneb, a metallo-organic pesticide like ziram, by activated carbon to levels less than 0.15 mg/l. Based on these data and the similarity of these two pesticides, the reduction of ziram by activated carbon to the equivalent pretreatment level of 0.15 mg/l (0.0145 lb/1,000 lbs in comingled pesticide streams at Plant 151 and 0.00078 lb/1,000 lbs in Plant 152) is judged to be technically feasible.

It was also reported by Little, et al., (1980) that maneb and related compounds are removed in biological treatment systems by approximately 50 percent. Therefore, a direct discharge effluent of 0.075 mg/l (0.00039 lb/1,000 lbs) in Plant 152 is judged to be technically feasible.

Subcategory 4--Fluometuron is a urea pesticide manufactured by Plant 153. The effluent currently discharged, without pesticide removal, is less than 27 mg/l (less than 30.5 lbs/1,000 lbs). Enzymatic hydrolysis has been reported by Mennecke (1976) and Plimmer (1971) to be effective in removing urea pesticides. Levels of decomposition were not

discussed but the authors stated that completed degradation of these pesticides may be demonstrated in full-scale applications. Two similarly-structured urea pesticides, diuron and linuron, were previously regulated in BPT to 0.0018 lb/1,000 lbs (30-day maximum) and 0.00129 lb/1,000 lbs (long-term average). It is currently predicted that 0.00129 lb/1,000 lbs is an achievable effluent via enzymatic hydrolysis, although further treatability studies are recommended.

A percent removal which is declared proprietary of linuron and dinuron has been reported through biological treatment. The direct discharge level of 0.00129 lb/ 1,000 lbs is predicted to be achievable after pesticide removal in the biological system, therefore a pretreatment level of 0.00243 lb/1,000 lbs is judged to be feasible.

Subcategory 5--Fensulfothion is a phosphorothioate pesticide which receives hydrolysis pretreatment at Plant 154. Plant data show that hydrolysis effluent down to levels which are declared proprietary can be achieved. Based on these proprietary data, 1 mg/l (0.00167 lb/ 1,000 lbs) is judged to be achievable by application of the recommended pretreatment technology for fensulfothion.

Data from Plant 154 show that an additional declared proprietary percent of the pesticide is removed via biological oxidation. Because of the large dilution in the final effluent of this plant, fensulfothion concentrations would not be detectable (<0.0015 mg/l) therefore monitoring in a segregated stream using the pretreatment achievable level of 0.00167 lb/1,000 lbs would be feasible.

ZAC is manufactured by Plant 155, which uses evaporation/crystallization to treat ZAC process wastewater prior to POTW discharge. Levels in the comingled pesticide streams discharged to the POTW have been reported to be 0.35 mg/l (0.0213 lb/1,000 lbs).

ZAC can be considered to be similar to the thiocarbamates which have been demonstrated to be removed by activated carbon (e.g., metham in Plant 88). It is therefore judged that if the wastewaters from the ZAC process combined with the other dithiocarbamates process wastewaters are treated by an activated carbon system similar to that currently employed by Plant 88, POTW discharge levels of 0.05 mg/l (detection limit for dithiocarbamates, ESE and EPA Method 630), equivalent to 0.003 lb/ 1,000 lbs, are technically feasible.

Zineb is manufactured by Plant 156. This plant uses evaporation/ crystallization to treat zineb process wastewater prior to POTW discharge. Effluent levels of 0.35 mg/l (0.0213 lb/1,000 lbs) for zineb in comingled pesticide streams have been reported by Plant 156. Little, et al. (1980) reported the reduction of maneb, a metallo-organic pesticide like zineb, by activated carbon to levels less than 0.15 mg/l. Based on these data and the similarity of these two pesticides, the reduction of zineb by activated carbon to the equivalent pretreatment level of 0.15 mg/l (0.0182 lb/1,000 lbs) in comingled pesticide streams in Plant 156 is judged to be technically feasible.

Subcategory 6--No pesticide active ingredients to be regulated.

Subcategory 7--No pesticide active ingredients to be regulated.

Subcategory 8--Aminocarb is one of the carbamate pesticides. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other carbamate pesticides similar to aminocarb, such as carbendazim which is currently manufactured by Plant 108, are being removed from wastewaters by activated carbon or hydrolysis to pretreatment levels which are declared proprietary and further reduced by a declared proprietary percentage by activated sludge. It is judged that if treatment of aminocarb wastewaters is required, this pesticide will react similarly in those above-mentioned technologies to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim--0.000226 lb/1,000 lbs direct discharge.

Fenuron is a urea herbicide in Subcategory 8. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Literature studies done by Mennecke (1976) and Plimmer (1971) reported enzymatic hydrolysis as an effective method to remove urea pesticides from wastewaters. Levels of decomposition were not discussed, but the authors stated that completed degradation of these pesticides may be demonstrated in full-scale applications. It is predicted that if treatment of fenuron wastewaters is required, pesticide effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) for this subcategory will be achievable via enzymatic hydrolysis, although further treatability studies are recommended.

Malathion is manufactured by Plant 157 which ocean discharges pesticide wastewater. Plant 172 uses hydrolysis to treat diazinon (a phosphorodithioate structurally similar to malathion) wastewater to a concentration which is declared proprietary. It is predicted that a hydrolysis system similar to the one employed at Plant 172 will remove malathion to equivalent concentrations and a pretreatment level of 0.000037 lb/1,000 lbs in Plant 157 will be achievable.

Methiocarb is one of the carbamate pesticides. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other carbamate pesticides similar to methiocarb, such as carbendazim which is currently manufactured by Plant 108, are being removed from wastewaters by activated carbon or hydrolysis to pretreatment levels which are declared proprietary and further reduced by a declared proprietary percentage by activated sludge. It is judged that if treatment of methiocarb wastewaters is required, this pesticide will react similarly in those above-mentioned technologies to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim--0.000226 lb/1,000 lbs direct discharge.

Mexacarbate is one of the carbamate pesticides. This pesticide is not currently manufactured and has not been monitored in the pesticide

industry; therefore, treatability information for it is not available. Other carbamate pesticides similar to mexacarbate, such as carbendazim which is currently manufactured by Plant 108, are being removed from wastewaters by activated carbon or hydrolysis to pretreatment levels which are declared proprietary and further reduced by a declared proprietary percentage by activated sludge. It is judged that if treatment of mexacarbate wastewaters is required, this pesticide will react similarly in those above-mentioned technologies to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim--0.000226 lb/1,000 lbs direct discharge.

Mirex is an aldrin-toxaphene pesticide in Subcategory 8 that is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other compounds which are structurally similar to mirex, such as heptachlor, are being removed from wastewaters by resin adsorption to levels which are declared proprietary. It is predicted that if treatment of mirex wastewaters is required, a resin adsorption system will reduce the pesticide to effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) recommended for Subcategory 8.

Monuron is a urea herbicide in Subcategory 8. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Literature studies done by Mennecke (1976) and Plimmer (1971) reported enzymatic hydrolysis as an effective method to remove urea pesticides from wastewaters. Levels of decomposition were not discussed but the authors stated that completed degradation of these pesticides may be demonstrated in full-scale applications. It is predicted that if treatment of monuron wastewaters is required, pesticide effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) for this subcategory will be achievable via enzymatic hydrolysis, although further treatability studies are recommended.

Parathion ethyl is manufactured by Plant 158, which uses hydrolysis to treat its parathion ethyl wastewater prior to indirect discharge. Plant 158 is currently achieving an average concentration which is declared proprietary following hydrolysis pretreatment. Based on these proprietary data a level of <0.00066 lb/1,000 lbs is judged to be achievable for parathion ethyl for indirect dischargers.

Parathion methyl is manufactured by Plants 159, 160, and 161. Plant 159 treats parathion methyl process wastewater by resin adsorption and activated carbon. No data are available to show effluent concentrations achieved at this plant. Plant 160 is achieving levels which are declared proprietary after pretreatment by hydrolysis. It is predicted that Plant 159 can achieve similar levels for parathion methyl as those reported by Plant 160. Plant 161 is achieving concentrations which are declared proprietary following hydrolysis pretreatment. Based on these proprietary data it is judged that Plants 159 and 160 can achieve a pretreatment effluent of <0.0183 lb/1,000 lbs and Plant 161 can achieve a pretreatment effluent of <0.00066 lb/1,000 lbs.

Parathion methyl was previously regulated to the BPT long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) for direct dischargers, and no additional removal has been technically demonstrated or economically warranted for new source direct dischargers.

Propham is one of the carbamate pesticides. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other carbamate pesticides similar to propham, such as carbendazim which is currently manufactured by Plant 108, are being removed from wastewaters by activated carbon or hydrolysis to pretreatment levels which are declared proprietary and further reduced by a declared proprietary percentage by activated sludge. It is judged that if treatment of propham wastewaters is required, this pesticide will react similarly in those above-mentioned technologies to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim--0.000226 lb/1,000 lbs direct discharge.

Propoxur is one of the carbamate pesticides. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other carbamate pesticides similar to propoxur, such as carbendazim which is currently manufactured by Plant 108, are being removed from wastewaters by activated carbon or hydrolysis to pretreatment levels which are declared proprietary and further reduced by a declared proprietary percentage by activated sludge. It is judged that if treatment of propoxur wastewaters is required, this pesticide will react similarly in those above-mentioned technologies to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim--0.000226 lb/1,000 lbs direct discharge.

Trifluralin is manufactured by Plant 162, which treats pesticide wastewater by activated carbon adsorption. Pesticides removed by this treatment have been reported to be greater than a declared proprietary percentage at Plant 162. Based on these proprietary data, a pretreatment level of 0.468 mg/l (0.00123 lb/1,000 lbs) is judged to be achievable.

Trifluralin was previously regulated to the BPT long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) for direct dischargers, and no additional removal has been technically demonstrated or economically warranted for new source direct dischargers.

Subcategory 9--Azinphos methyl is manufactured by Plant 163. The plant reports that effluent levels which are declared proprietary are achievable after hydrolysis, the recommended technology. Additional removal by hydrolysis to pretreatment levels less than 0.1 mg/l (equivalent to 0.00107 lb/1,000 lbs) is technically feasible, according to plant data, by upgrading the existing hydrolysis system (increasing the detention time from 2 to 4 hours). Therefore, the pretreatment value of 0.00107 lb/1,000 lbs is technically achievable.

Azinphos methyl was previously regulated to the BPT long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) for direct dischargers, and no additional removal has been technically demonstrated or economically warranted for new source direct dischargers.

Captan is manufactured by Plant 164 which disposes its process wastewater by deep well injection. Wolfe, et al. (1976) reported that this pesticide readily undergoes hydrolysis in water with a maximum half-life of 155 min at 20°C and pH of 7. Based on this information it is predicted that a hydrolysis system at Plant 164 can reduce captan to its detection limit concentration (0.001 mg/l) and pretreatment level of 0.0000107 lb/ 1,000/lbs will be achievable.

Carbaryl--is manufactured at Plant 165 which treats its process wastewater by gravity separation and biological oxidation before it is direct discharged. No data are available from the plant on removal of this pesticide or on effluents achieved after treatment. The removal of this carbamate pesticide by activated carbon and hydrolysis has been extensively reported. Metham, also a carbamate pesticide, is being treated by activated carbon at Plant 88 to effluent levels which are declared proprietary. Based on these proprietary data a pretreatment level of 0.0000214 lb/1,000 lbs is judged to be achievable for carbaryl at Plant 165.

Carbaryl was previously regulated to the BPT long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) for direct dischargers, and no additional removal has been technically demonstrated or economically warranted for new source direct dischargers.

Chlorpropham is one of the carbamate pesticides. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other carbamate pesticides similar to chlorpropham, such as carbendazim which is currently manufactured by Plant 108, are being removed from wastewaters by activated carbon or hydrolysis to pretreatment levels which are declared proprietary and further reduced by a declared proprietary percentage by activated sludge. It is judged that if treatment of chlorpropham wastewaters is required, this pesticide will react similarly in those above-mentioned technologies to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim--0.000226 lb/1,000 lbs direct discharge.

2,4-D is manufactured by Plants 166, 167, and 168. Plant 166 uses activated carbon to pretreat the wastewater from the pesticide process prior to POTW discharge. Activated carbon effluent levels of <0.0359 mg/l (<0.00109 lb/1,000 lbs) have been recently reported. It is predicted that an activated carbon system similar to the one employed by Plant 166 will remove this pesticide to equivalent concentrations (<0.0359 mg/l) and pretreatment levels of 0.000248 lb/1,000 lbs in Plant 167 will be feasible. Plant 168 uses resin adsorption to pretreat this pesticide wastewater. POTW discharge levels are reported to be <2.14 mg/l (<0.0385 lb/1,000 lbs). It is predicted that by upgrading the existing resin adsorption system, effluent concentrations of

<0.0359 mg/l at Plant 168 will be feasible and pretreatment levels of <0.000686 lb/1,000 lbs will be achievable.

DCNA--This pesticide is manufactured by Plant 171. Part of this pesticide process wastewater is discharged to a POTW, the other portion is direct discharged. Pretreatment levels prior to POTW discharge have been reported by the plant to be <1.0 mg/l (0.281 lb/1,000 lbs). Activated carbon has been demonstrated to remove propachlor (an amide pesticide structurally similar to DCNA) at Plant 140 to concentrations which are declared proprietary. It is predicted that an activated carbon system similar to the one employed by Plant 140 will remove DCNA to equivalent concentrations and pretreatment levels of 0.00035 lb/1,000 lbs will be achievable by monitoring in a segregated stream.

DCNA was previously regulated to the BPT long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) for direct dischargers, and no additional removal has been technically demonstrated or economically warranted for new source direct dischargers.

Demeton-o is one of the phosphorothioate pesticides in Subcategory 9. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other phosphorothioate pesticides similar to demeton-o, such as parathion and diazinon, are being removed from wastewaters by hydrolysis to concentrations which are declared proprietary. It is predicted that if treatment of demeton-o is required, a hydrolysis treatment system will technically reduce the pesticide to effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) recommended for Subcategory 9.

Demeton-s is one of the phosphorothioate pesticides in Subcategory 9. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other phosphorothioate pesticides similar to demeton-s, such as parathion and diazinon, are being removed from wastewaters by hydrolysis to concentrations which are declared proprietary. It is predicted that if treatment of demeton-s is required, a hydrolysis treatment system will technically reduce the pesticide to effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) recommended for Subcategory 9.

Diazinon is manufactured by Plants 172 and 173. Plant 172 pretreats its diazinon wastewaters by hydrolysis. Plant data show that a hydrolysis effluent down to levels which are declared proprietary is achievable. Based on these proprietary data, the achievable pretreatment level for diazinon at Plant 172 is judged to be 0.000977 lb/1,000 lbs. It is also predicted that a hydrolysis system similar to the one employed at Plant 172 will remove diazinon at Plant 173 to equivalent concentrations and pretreatment levels of 0.00613 lb/1,000 lbs in Plant 173 will be achievable.

Diazinon was previously regulated to the BPT long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) for direct dischargers, and no

additional removal has been technically demonstrated or economically warranted for new source direct dischargers.

Dicamba is manufactured by Plant 174, which disposes its pesticide wastewater by deep well injection. PCNB, a halogenated aromatic pesticide like dicamba is being treated by activated carbon at Plant 179 to concentrations which are declared proprietary. It is predicted that an activated carbon system similar to the one employed by Plant 179 will remove dicamba to equivalent concentrations and a pretreatment level lower than 0.00322 lb/1,000 lbs in Plant 174 will be achievable.

Dicofol is a DDT-type pesticide in Subcategory 9. This pesticide is not currently manufactured and has not been monitored in the pesticide industry, but literature studies (Love, 1977; Whitehouse, 1967; Eichelberger, 1971; and Hager, 1976) have extensively reported up to 95 to 99 percent removal of DDT, methoxychlor, and other DDT-type pesticides by activated carbon. Chlorobenzilate, a DDT-type pesticide similar to dicofol, is treated in Plant 110 by biological treatment, and removal rates which are declared proprietary have been reported. Based on these proprietary data, it is predicted that if treatment of dicofol wastewaters is required, an activated carbon/biological treatment combination system will technically achieve effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) recommended for Subcategory 9.

Disulfoton is manufactured by Plant 175, which treats its process wastewater by hydrolysis. Removal of disulfoton by hydrolysis has been reported to be up to a declared proprietary percentage, achieving pretreatment levels which are declared proprietary. Additional removal by hydrolysis to pretreatment levels less than 1 mg/l (equivalent to 0.0312 lb/1,000 lbs) is technically feasible based on plant data, by upgrading the existing hydrolysis system (increasing the detention time from 2 to 4 hours). Therefore the pretreatment value of 0.0312 lb/1,000 lbs is technically achievable for disulfoton.

Disulfoton was previously regulated to the BPT long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) for direct dischargers, and no additional removal has been technically demonstrated or economically warranted for new source direct dischargers.

Diuron is manufactured by Plant 176. This pesticide was previously regulated under BPT for direct dischargers to levels of 0.00129 lb/1,000 lbs (a long-term average). Data from Plant 176 show that a declared proprietary percent removal of diuron is achievable through biological oxidation. Based on these data, a pretreatment level of 0.00243 lb/1,000 lbs is judged to be achievable.

Fenuron-TCA is a urea herbicide in Subcategory 9. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Literature studies done by Mennecke (1976) and Plimmer (1971) reported enzymatic hydrolysis as an effective method to remove urea pesticides from wastewaters. Levels of decomposition were not discussed but the authors stated that completed degradation of these pesticides may be

demonstrated in full-scale applications. It is predicted that if treatment of fenuron-TCA wastewaters is required, pesticide effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) for this subcategory will be achievable via enzymatic hydrolysis, although further treatability studies are recommended.

Linuron is manufactured by Plant 177. This pesticide was previously regulated under BPT for direct dischargers to levels of 0.00129 lb/1,000 lbs (a long-term average). Data from Plant 177 show that a declared proprietary percent removal of linuron is achievable through biological oxidation. Based on these data, a pretreatment level of 0.00243 lb/1,000 lbs is judged to be achievable.

Methoxychlor is a DDT-type pesticide which is manufactured by Plant 178, which discharges the methoxychlor process wastewater, without pretreatment, to a POTW. The removal of DDT-type pesticides (up to 95 to 99 percent by activated carbon) has been extensively reported (Love, 1977; Whitehouse, 1967; Eichelberger, 1971; and Hager, 1976). It is predicted that treatment by this technology will remove methoxychlor to the detection limit of 0.001 mg/l (Method for Organochlorine Pesticides, Federal Register, 11/28/73). Based on these data, it is judged that a system designed similarly to those reported in the literature will achieve pretreatment levels of 3.75×10^{-5} lb/1,000 lbs (assuming average flow for the pesticide industry) at Plant 178.

Monuron-TCA is a urea herbicide in Subcategory 9. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Literature studies done by Mennecke (1976) and Plimmer (1971) reported enzymatic hydrolysis as an effective method to remove urea pesticides from wastewaters. Levels of decomposition were not discussed, but the authors stated that completed degradation of these pesticides may be demonstrated in full-scale applications. It is predicted that if treatment of monuron-TCA wastewaters is required, pesticide effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) for this subcategory will be achievable via enzymatic hydrolysis, although further treatability studies are recommended.

Neburon is a urea herbicide in Subcategory 8. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Literature studies done by Mennecke (1976) and Plimmer (1971) reported enzymatic hydrolysis as an effective method to remove urea pesticides from wastewaters. Levels of decomposition were not discussed but the authors stated that completed degradation of these pesticides may be demonstrated in full-scale applications. It is predicted that if treatment of neburon wastewaters is required, pesticide effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) for this subcategory will be achievable via enzymatic hydrolysis, although further treatability studies are recommended.

PCNB is manufactured by Plant 179, which treats its process wastewater by activated carbon. Pesticide removal greater than a declared

proprietary percentage has been reported, achieving levels of 0.0182 mg/l (0.0000765 lb/1,000 lbs) in the final discharge. Based on these data, a level of 0.0000765 lb/1,000 lbs is judged to be achievable for direct dischargers of PCNB.

Perthane is a DDT-type pesticide in Subcategory 9. This pesticide is not currently manufactured and has not been monitored in the pesticide industry, but literature studies (Love, 1977; Whitehouse, 1967; Eichelberger, 1971; and Hager, 1976) have extensively reported up to 95 to 99 percent removal of DDT, methoxychlor, and other DDT-type pesticides by activated carbon. Chlorobenzilate, a DDT-type pesticide similar to perthane, is treated in Plant 110 by biological treatment, and removal rates up to a declared proprietary percentage have been reported. Based on these proprietary data, it is predicted that if treatment of perthane wastewaters is required, an activated carbon/biological treatment combination system will technically achieve effluent levels of 0.0344 mg/l (0.00129 lb/1,000 lbs) recommended for Subcategory 9.

Silvex is manufactured by Plant 180, which discharges its process wastewater to a POTW. 2,4-D, a chlorinated aryloxyalkanoic pesticide structurally similar to silvex, is being treated in a full scale activated carbon system at Plant 166 to concentrations <0.05 mg/l. It is predicted that an activated carbon system similar to the one employed by Plant 166 will remove this pesticide to equivalent concentrations (<0.05 mg/l) and pretreatment levels of 0.000469 lb/1,000 lbs in Plant 180 will be achievable.

SWEP is one of the carbamate pesticides. This pesticide is not currently manufactured and has not been monitored in the pesticide industry; therefore, treatability information for it is not available. Other carbamate pesticides similar to SWEP, such as carbendazim which is currently manufactured by Plant 108, are being removed from wastewaters by activated carbon or hydrolysis to pretreatment levels which are declared proprietary and further reduced by a declared proprietary percentage by activated sludge. It is judged that if treatment of SWEP wastewaters is required, this pesticide will react similarly in those above-mentioned technologies to achieve pretreatment and direct discharge levels equivalent to those achievable for carbendazim--0.000226 lb/1,000 lbs direct discharge.

2,4,5-T is manufactured by Plant 181, which discharges its process to a POTW. 2,4-D, a chlorinated aryloxyalkanoic pesticide like 2,4,5-T, is being treated in a full scale activated carbon system at Plant 166 to concentrations <0.05 mg/l. It is predicted that an activated carbon system similar to the one employed by Plant 166 will remove 2,4,5-T to equivalent concentrations (<0.05 mg/l) and pretreatment levels of 0.000458 lb/1,000 lbs in Plant 181 will be achievable.

Subcategory 10--Ametryne is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis by two plants using hydrolysis, and by three plants using granular activated carbon. Treatability

studies by Lai (1977) have shown that ametryne can be hydrolyzed under acid conditions at rates equivalent to those for triazines being treated on a full-scale basis. Data for Plant 182, the only manufacturer of ametryne, show that the raw waste load for this pesticide is a declared proprietary value. Based on the full-scale and treatability data presented previously, it is judged that an activated carbon or hydrolysis system, similar to that presented in this document, can achieve a pretreatment effluent of 1 mg/l (0.0126 lb/1,000 lbs).

Data from Plant 182 show that approximately a declared proprietary percentage of the pesticide is removed in biological oxidation. Based on these data, a direct discharge effluent of 0.0116 lb/1,000 lbs is judged to be achievable.

Atrazine is a pesticide in the triazine structural group. Plants 183 and 184, manufacturers of this pesticide, use granular activated carbon for its removal. Data show that for these plants which discharge to navigable waters, levels which are declared proprietary are being achieved. Treatability studies by Little, et al. (1980), Lowenback (1977), Armstrong, et al. (1967), and Brown, et al. (1972), have shown that hydrolysis of atrazine is accomplished at rates similar to triazines such as cyanazine, which is hydrolized on a full-scale basis at Plant 185 to levels which are declared proprietary. Based on available information, it is concluded that atrazine can be treated to the same concentration level as cyanazine, after existing systems at Plants 183 and 184 have been upgraded with additional hydrolysis or activated carbon, therefore pretreatment levels of 0.0441 lb/1,000 lbs for Plant 183 and 0.00394 lb/1,000 lbs for Plant 184 are judged to be feasible.

Removal of triazine pesticides by biological treatment has been reported to be in a range of 8.23 to 40 percent. Based on these data it is predicted that a 30 percent removal of atrazine by biological treatment can be achieved and direct discharge levels of 0.0309 lb/1,000 lbs at Plant 183 and 0.00276 lb/1,000 lbs at Plant 184 will be feasible.

Cyanazine, a triazine pesticide, is currently manufactured by Plant 185 and in the past was manufactured by Plant 186. Plant 185 uses hydrolysis to treat the wastewater from the cyanazine process and reports greater than a declared proprietary percent removal of cyanazine through hydrolysis, achieving a final effluent level of <0.1 mg/l (<0.00267 lb/1,000 lbs). Plant 186 formerly treated this pesticide wastewater only by biological oxidation, with a raw waste load which is declared proprietary.

Based on the data available, it is judged if Plant 186 resumed production of cyanazine that a hydrolysis system designed similar to that in Plant 185 can achieve a pretreatment effluent of 0.1 mg/l (0.0042 lb/1,000 lbs).

According to Plant 186 data, there is a declared proprietary percent removal of cyanazine through biological treatment. Based on these proprietary data, direct discharge levels of 0.0042 lb/1,000 lbs for

Plant 186 and 0.00267 lb/1,000 lbs for Plant 185 are judged to be achievable.

Metribuzin is a triazine pesticide manufactured by Plant 187, which uses hydrolysis as a pretreatment system. Plant data show the hydrolysis effluent levels which are declared proprietary. Final effluent levels of less than 0.49 mg/l (0.234 lb/1,000 lbs) have been reported. Based on plant data, additional hydrolysis of metribuzin to 0.01 mg/l (which is higher than the detection limit for metribuzin, per EPA Method 633—0.7 ug/l) equivalent to 0.000135 lb/1,000 lbs is achievable by increasing the detention time from 3 hours to 5.5 hours.

According to plant data, metribuzin is removed an additional declared proprietary percentage through biological oxidation. Because of the large amount of dilution in the biological treatment of this plant, the direct discharge effluent is estimated to equal pretreatment effluent levels of 0.000135 lb/1,000 lbs. It is recommended that monitoring be conducted in segregated wastewater after pretreatment.

Prometon is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis at two plants using hydrolysis, and at three plants using granular activated carbon. Data for Plant 188, the only manufacturer of prometon, show that the raw waste load for this pesticide is a declared proprietary value. Based on the full-scale information presented above, it is judged that an activated carbon or hydrolysis system designed similarly to that presented in this document can achieve an effluent of 1 mg/l (0.00501 lb/1,000 lbs) for pretreatment.

Data from Plant 188 show that approximately a declared proprietary percentage of the pesticide is removed in biological oxidation. Based on these proprietary data, a direct discharge effluent of 0.00305 lb/1,000 lbs is judged to be achievable.

Prometryn is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis at two plants using hydrolysis, and at three plants using granular activated carbon. Treatment studies by Kearney (1969) have shown that prometryn can be hydrolyzed under acid conditions at rates equivalent to those for triazines being treated on a full-scale basis. Data for Plant 189, the only manufacturer of prometryn show that the raw waste load for this pesticide is a declared proprietary value. Based on the full-scale and treatability data presented, it is judged that an activated carbon or hydrolysis system similar to that presented in this report can achieve an effluent of 1 mg/l (0.00907 lb/1,000 lbs) for pretreatment regulations.

Data from Plant 189 show that approximately a declared proprietary percentage of the pesticide is removed in biological oxidation. Based on these proprietary data, a direct discharge effluent of 0.00643 lb/1,000 lbs is judged to be achievable.

Propazine is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis at two plants using hydrolysis, and at three plants using granular activated carbon. Data for Plant 190 show that the raw waste load for this pesticide is a declared proprietary value. Plant 191 reports propazine levels which are declared proprietary in comingled pesticide streams after pretreatment by activated carbon. Based on the full-scale and treatability data presented for similar triazines, it is judged that an activated carbon or hydrolysis system similar to that presented in this document can achieve an effluent of 1 mg/l (0.0583 lb/1,000 lbs at Plant 190 and 0.0394 lb/1,000 lbs in comingled streams at Plant 191) for pretreatment regulations.

Data from Plant 190 show that approximately a declared proprietary percentage of the pesticide is removed in biological oxidation. Based on these proprietary data, direct discharge effluents of 0.0493 lb/1,000 lbs at Plant 190 and 0.0333 lb/1,000 lbs in comingled streams at Plant 191 are judged to be achievable.

Simazine is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis at two plants using hydrolysis, and at three plants using granular activated carbon. Treatability studies by Lai (1977) have shown that simazine can by hydrolyzed under acid conditions at rates equivalent to those for triazines being treated on a full-scale basis. Plant 192 reports that the raw waste load for this pesticide is a declared proprietary value. Plant 193 reports simazine of a declared proprietary value in comingled pesticide streams after pretreatment by activated carbon. Based on the full-scale and treatability data presented for similar triazines, it is judged that an activated carbon or hydrolysis system similar to that presented in this document can achieve a pretreatment effluent of 1 mg/l (0.0577 lb/1,000 lbs at Plant 192 and 0.0394 lb/1,000 lbs in comingled streams at Plant 193).

Data from Plant 192 show that approximately a declared proprietary percentage of similar triazine pesticides is removed in biological oxidation. Based on these proprietary data, direct discharge effluents of 0.0364 lb/1,000 lbs at Plant 192 and 0.0249 lb/1,000 lbs in comingled pesticide streams at Plant 193 are judged to be achievable.

Simetryne is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis at two plants using hydrolysis, and at three plants using granular activated carbon. Plant 194, the only manufacturer of simetryne, reports that the raw waste load for this pesticide is a declared proprietary value. Based on the full-scale and treatment data presented for similar pesticides, it is judged that an activated carbon or hydrolysis system similar to that presented in this document can achieve a pretreatment effluent of 1 mg/l (0.00453 lb/1,000 lbs).

Data from Plant 194 show that approximately a declared proprietary percentage of the pesticide is removed in biological oxidation. Based on these proprietary data, a direct discharge effluent of 0.00326 lb/1,000 lbs is judged to be achievable.

Terbuthylazine is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis at two plants using hydrolysis, and at three plants using granular activated carbon. Plant 195, the only manufacturer of terbuthylazine, has no raw waste load data for this pesticide. Based on the full-scale and treatability data presented for similar triazines, it is judged that an activated carbon or hydrolysis system similar to that presented in this document can achieve a pretreatment effluent of 1 mg/l (0.0200 lb/1,000 lbs).

Data from Plant 195 show that approximately a declared proprietary percentage of similar triazine pesticides is removed in biological oxidation. Based on these proprietary data, a direct discharge effluent of 0.0144 lb/1,000 lbs is judged to be achievable.

Terbutryn is one of 14 similarly-structured pesticides known as triazines. The removal of triazine pesticides has been established on a full-scale basis at two plants using hydrolysis, and at three plants using granular activated carbon. Plant 196, the only manufacturer of terbutryn, has no raw waste load data for this pesticide. Based on the full-scale and treatability data presented for similar triazines, it is judged that an activated carbon or hydrolysis system similar to that presented in this document can achieve a pretreatment effluent of 1 mg/l (0.00755 lb/1,000 lbs).

Data from Plant 196 show that approximately a declared proprietary percentage of similar triazine pesticides is removed in biological oxidation. Based on these proprietary data, a direct discharge effluent of 0.00544 lb/1,000 lbs is judged to be achievable.

Subcategory 11--Because the only known manufacturer of alkylamine hydrochloride, Plant 197, does not generate any wastewater, a zero discharge effluent is achievable.

Because Plant 198, the only known manufacturer of amobam does not generate any wastewater, a zero discharge effluent is achievable.

Because Plant 199, the only known manufacturer of barban, totally evaporates all process wastewater, a zero discharge effluent is achievable.

Because the only known manufacturer of BBTAC, Plant 200, does not generate any wastewater, a zero discharge effluent is achievable.

Because Plant 201, a manufacturer of biphenyl, has stated it does not discharge any wastewater, a zero discharge effluent is achievable.

Because three of the four plants (Plants 202, 203, and 204) known to manufacture chloropicrin recycle or reuse all process wastewater, a zero discharge is achievable by those three plants.

Because Plant 205, a manufacturer of 2,4-D isooctyl ester does not generate any wastewater, a zero discharge is achievable for this plant.

Because Plant 206, the only manufacturer of 2,4-D salt, does not generate wastewater, a zero discharge effluent is achievable.

Because the manufacturers of D-D (Plants 207, 208, 209) do not generate any wastewater or recycle/reuse, a zero discharge effluent is achievable.

Because the only manufacturer of dichlorophen salt, Plant 210, does not generate any wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of dowicil 75, Plant 211, totally evaporates all process wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of ethoprop, Plant 212, totally evaporates all process wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of fluoroacetamide, Plant 213, does not generate any wastewater, a zero discharge effluent is achievable.

Because Plant 214, the only manufacturer of glyodin, does not generate any wastewater, a zero discharge effluent is achievable.

Because Plant 215, the only manufacturer of HPTMS, totally evaporates all process wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of merphos, Plant 216, totally evaporates all process wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of metasol J-26, Plant 217, does not generate any wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of pyrethrin, Plant 218, does not generate any wastewater, a zero discharge effluent is achievable.

Because Plant 219, the only manufacturer of silvex isooctyl ester, does not generate any wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of silvex salt, Plant 220, does not generate wastewater, a zero discharge effluent is achievable.

Plant 221, a manufacturer of sodium monofluoroacetate evaporates all the wastewater that is generated from this pesticide process; therefore, a zero discharge effluent is achievable.

Because the only manufacturer of tributyltin benzoate, Plant 222, does not generate wastewater, a zero discharge effluent is available.

Because Plant 223, a manufacturer of tributyltin oxide does not generate any wastewater, a zero discharge effluent is achievable.

Because the only manufacturer of Vancide TH, Plant 224, does not generate wastewater, a zero discharge effluent is available.

Because the only manufacturer of Vancide 51Z, Plant 225, does not generate wastewater, a zero discharge effluent is available.

Because the only manufacturer of Vancide 51Z dispersion, Plant 226, does not generate wastewater, a zero discharge effluent is achievable.

Ziram is manufactured by Plant 227. Because this plant does not generate any wastewater, a zero discharge is achievable.

Subcategory 12--Based on the BPT regulation of zero discharge for direct discharge metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products, a zero discharge effluent is judged achievable for indirect dischargers and direct dischargers. There is no process distinction between direct and indirect discharge metallo-organic pesticide manufacturers.

Subcategory 13--Based on the BPT regulation of zero discharge for direct discharge pesticide formulator/packagers, a zero discharge effluent is judged achievable for indirect dischargers and direct dischargers. There is no process distinction between direct and indirect discharge pesticide formulator/packagers.

Method of Calculating Long-Term Averages

The following discussion presents the method of calculating the effluent long-term average for priority pollutants, nonconventional pesticides, BOD, TSS, and COD for appropriate regulations.

The pollutant parameters which are subject to each regulation are presented below.

Parameters Proposed for Pollutant Regulation	Regulation			
	BAT	NSPS	PSES	PSNS
Priority Pollutants	X*	X	X	X
Nonconventional Pesticides	X†	X	X	X
Conventional Pollutants BOD, TSS, pH	-	X	-	-
Nonconventional Pollutant COD	-	X	-	-

X Subject to regulation.
- Not subject to regulation.
* Excluding 9 priority pollutant pesticides previously regulated for direct discharge under BPT.
† Excluding 36 nonconventional pesticides previously regulated for direct discharge under BPT.

The long-term average effluents for each pollutant were selected based on the previously presented evaluations of effluent levels achieved and effluent levels achievable. The results of this selection process are presented in Tables XV-19 through XV-21. These long-term averages will be subsequently combined with treatment variability factors to define the 30-day maximum and daily maximum effluent limitations and pretreatment standards.

The selection process insured that the proposed long-term averages were based on the best available treatment technology, by consideration of data from the following four sources:

1. Effluents currently achieved in the industry,

2. Effluents currently achieved outside the industry (transfer technology),

3. Design effluents achievable by applying recommended technology to maximum design raw waste loads for the industry, and

4. Effluents achievable by applying recommended technology to raw waste loads at specific plants.

Priority Pollutant Long-Term Average for Direct Discharge (BAT/NSPS)--The selection of priority pollutant long-term averages is presented below by priority pollutant group.

Volatile Aromatics--The proposed long-term average effluent for benzene, chlorobenzene, and toluene is <0.01 mg/l (<0.00037 lb/1,000 lbs) based on effluents currently achieved in the industry for biological treatment. Based on available data for pesticide processes with the recommended treatment, four discrete pesticide processes are currently achieving the average of <0.00037 lb/1,000 lbs for both benzene and toluene whereas one pesticide is achieving the average for chlorobenzene.

The proposed long-term average effluent for 1,2-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene is 0.0525 lb/1,000 lbs for only those processes in which they are the manufactured product. In all other processes these pollutants are expected to be controlled by regulation of chlorobenzene. The long-term average of 0.0525 lb/1,000 lbs is the same as that selected for the Subcategory 2 nonconventional pesticide parameter since 1,2-dichlorobenzene, 1,4-dichlorobenzene, and 1,2,4-trichlorobenzene are only proposed for regulation as the manufactured product. As previously stated in this section, the effluents achieved and predicted effluents achievable for the plants which manufacture these compounds have been provided and were considered in the selection of the nonconventional pesticide parameter for Subcategory 2.

Halomethanes--The proposed long-term average effluent for carbon tetrachloride, chloroform, methyl bromide, methyl chloride, and

methylene chloride is <0.01 mg/l (<0.00037 lb/1,000 lbs) based on design effluents for steam stripping and effluents currently achieved in the industry for biological treatment. Based on available data for pesticide processes with the recommended treatment, one pesticide process is currently achieving the average of <0.00037 lb/1,000 lbs for chloroform and methylene chloride. However, no pesticides are currently achieving the average for methyl bromide, carbon tetrachloride, and methyl chloride.

Cyanide--The proposed long-term average effluent for cyanide is 0.02 mg/l (0.00075 lb/1,000 lbs) based on transfer technology from the electroplating industry for chemical oxidation, and effluents currently achieved in the industry for biological treatment. Based on available data for pesticide processes with the recommended treatment, four discrete, direct discharge pesticide processes are currently achieving this average.

Haloethers--The proposed long-term average effluent for bis(2-chloroethyl) ether (dichloroethyl ether) is zero for only those processes in which it is the manufactured product. These processes are currently achieving zero discharge of all process wastewater pollutants. Bis(2-chloroethyl) ether is proposed to be excluded from regulation in all other processes pending the collection of adequate monitoring data.

Phenols--The proposed long-term average effluent for 2,4-dichlorophenol, 2,4-dinitrophenol, 4-nitrophenol, PCP, and phenol is 0.1 mg/l (0.0037 lb/1,000 lbs) based on effluents currently achieved in the industry for activated carbon and biological treatment. Based on available data for pesticide processes with the recommended treatment, two discrete pesticide processes are currently achieving this average for 2,4-dichlorophenol and phenol. However, no direct discharge pesticides are currently achieving the effluent average for 2,4-dinitrophenol, 4-nitrophenol, and PCP.

Metals--The proposed long-term average effluent for copper and zinc is 0.25 mg/l (0.0094 lb/1,000 lbs) based on transfer technology from the electroplating and battery industries for metals separation, and percent removal currently achieved in the pesticide industry for biological treatment. Based on available data for pesticide processes with the recommended treatment, one pesticide is currently achieving the selected effluent average of 0.0094 lb/1,000 lbs for copper. However, the selected effluent average of 0.0094 lb/1,000 lbs for zinc is not currently being achieved by any direct discharger.

Chlorinated Ethanes and Ethylenes--The proposed long-term average effluent for 1,2-dichloroethane and tetrachloroethylene is 0.1 mg/l (0.0037 lb/1,000 lbs) based on design effluents for steam stripping and percent removal currently achieved in the industry for biological treatment. Based on available data for pesticide processes with the recommended treatment, there is one direct discharge pesticide is currently achieving the effluent average for 1,2-dichloroethane and tetrachloroethylene.

Nitrosamines--The proposed long-term average effluent for n-nitrosodi-n-propylamine is 0.001 mg/l (0.000037 lb/1,000 lbs) based on effluents currently achieved in the industry for activated carbon treatment. According to current data, there is an apparent increase in this pollutant across biological treatment; therefore, monitoring after activated carbon pretreatment is recommended. Based on available data for pesticide processes with the recommended treatment, the selected effluent average of 0.000037 lb/1,000 lbs is currently being achieved by one direct discharge pesticide.

Dichloropropane and Dichloropropene--The proposed long-term average effluent for 1,3-dichloropropene is zero for only those processes in which it is the manufactured product. These processes are currently achieving zero discharge of all process wastewater pollutants. 1,3-Dichloropropene is proposed to be excluded from regulation in all other processes pending the collection of adequate monitoring data.

Dienes--The proposed long-term average effluent for hexachlorocyclopentadiene (HCCPD) is 0.023 mg/l (0.00086 lb/1,000 lbs) based on effluents currently achieved by resin adsorption and percent removal achievable from biological treatment. There are no available data for pesticide processes with the recommended treatment which document effluent levels achieved for HCCPD for direct dischargers.

Priority Pollutant Pesticides--The priority pollutant pesticides BHC-alpha, BHC-beta, BHC-delta, endosulfan-alpha, endosulfan-beta, endrin, heptachlor, lindane (BHC-gamma), and toxaphene were previously regulated for existing direct discharge and, therefore, do not apply to the BAT regulation. However, these pollutant parameters are subject to the NSPS regulation where the BPT direct discharge long-term average of 0.0344 mg/l (0.00129 lb/1,000 lbs) was selected.

The selected long-term averages for direct discharge of priority pollutants is presented in Table XV-19.

Nonconventional Pesticide Long-Term Average for Direct Discharge (BAT/NSPS)--The long-term average effluents for nonconventional pesticides were derived by first evaluating the effluent levels achievable for only those direct discharge pesticides to be regulated in a given subcategory; second, by determining the maximum effluent achievable value for each subcategory; and third, by using this maximum value as the long-term average for that subcategory. The long-term average effluents were selected from achievable values for direct dischargers utilizing pesticide removal and biological treatment. EPA chose the least treatable pollutant as the defining standard for that parameter. Accordingly, the number selected for the subcategory represented the highest effluent achievable value. This selection process insured that the average for each subcategory could be achieved by each pesticide within that subcategory. Table XV-20 lists the long-term average effluents for nonconventional pesticides by subcategory.

The selection of pesticide long-term average effluents is presented below by subcategory.

Subcategory 1--The highest effluent achievable value of 15 discrete direct discharge pesticide processes was found to be 0.0261 lb/1,000 lbs (0.0243 mg/l) for terbacil at Plant 96 following pesticide removal and biological treatment. This value was therefore selected as the pesticide long-term average effluent for Subcategory 1. Based on available data, five pesticides to be regulated in Subcategory 1 show that the selected long-term average effluent is currently being achieved.

Subcategory 2--The highest effluent achievable of 37 discrete direct discharge pesticide processes was found to be 0.0525 lb/1,000 lbs (0.185 mg/l) for profluralin at Plant 139 following pesticide removal and biological treatment. This value was therefore selected as the pesticide long-term average effluent of Subcategory 2. Based on available data, the long-term average effluent is currently being achieved by eleven pesticides which are proposed for regulation.

Subcategory 3—The highest effluent achievable of two direct discharge pesticide processes was found to be 0.00473 lb/1,000 lbs (0.15 mg/l) for maneb at Plant 148 following pesticide removal and biological treatment. This value was therefore selected as the pesticide long-term average effluent for Subcategory 3. There are no data available which document the effluent levels achieved for pesticides to be regulated in Subcategory 3.

Subcategory 4--Only one pesticide, fluometuron, is proposed to be regulated in Subcategory 4 for the pesticide parameter. Therefore the effluent achievable value of 0.00129 lb/1,000 lbs (0.00134 mg/l) for fluometuron at Plant 153 was selected as the long-term average effluent for this subcategory. Based on available data, Plant 153 is not currently achieving the selected pesticide long-term average.

Subcategory 5--Fensulfothion is the only pesticide in Subcategory 5 which is proposed for regulation for the pesticide parameter and from which wastewater is directly discharged. Therefore, the effluent achievable value of 0.00167 lb/1,000 lbs (1.0 mg/l) for fensulfothion at Plant 154 was selected as the long-term average effluent for this subcategory. Based on available data, Plant 154 is not currently achieving the selected pesticide long-term average.

Subcategory 6--All pesticides listed in Subcategory 6 are not proposed for regulation due to lack of acceptable analytical methods; therefore, no pesticide long-term average effluent has been selected.

Subcategory 7--All pesticides listed in Subcategory 7 are not proposed for regulation due to lack of acceptable analytical methods; therefore, no pesticide long-term average effluent has been selected.

Subcategory 8--All pesticides in Subcategory 8 were regulated for the pesticide parameter during BPT for direct dischargers; therefore no

BAT long-term average effluent has been selected. However, these pesticides are subject to the NSPS regulation where the BPT direct discharge long-term average effluent of 0.00129 lb/1,000 lbs is applicable.

Subcategory 9--All pesticides in Subcategory 9 were regulated for the pesticide parameter during BPT for direct dischargers; therefore no BAT long-term average effluent has been selected. However, these pesticides are subject to the NSPS regulation where the BPT direct discharge long-term average of 0.00129 lb/1,000 lbs is applicable.

Subcategory 10--The highest effluent achievable value of 15 discrete, direct discharge pesticide processes was found to be 0.0493 lb/1,000 lbs (0.163 mg/l) for propazine at Plant 190 following pesticide removal and biological treatment. This value was therefore selected as the pesticide long-term average effluent for Subcategory 10. Based on available data, one pesticide process to be regulated in Subcategory 10 show that the selected long-term average effluent is currently being achieved.

Subcategory 11--All pesticides in Subcategory 11 are proposed for regulation to a zero discharge effluent limitation since there is no discharge of pesticide process wastewater.

Subcategory 12--All existing metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products were regulated during BPT for direct dischargers; therefore, no BAT long-term average effluent has been selected. However, these pesticides are subject to the NSPS regulation where the BPT direct discharge effluent limitation of zero discharge is proposed.

Subcategory 13--All existing pesticide formulator/packagers were regulated during BPT for direct dischargers; therefore, no BAT long-term average effluent has been selected. However, formulator/packagers are subject to the NSPS regulation where the BPT direct discharge effluent limitation of zero discharge is proposed.

Conventional Pollutants BOD and TSS Long-Term Average for Direct Discharge (NSPS)--

BOD and TSS are not applicable to the BAT regulation; however, they are proposed for regulation under NSPS and are judged to be equivalent to the BPT limitation, since the biological treatment recommended to remove these pollutants is common to both NSPS and BPT. The long-term average for BOD and TSS is therefore 1.12 lbs/1,000 lbs and 1.31 lbs/1,000 lbs, respectively, as shown in Table XV-21.

Nonconventional Pollutant COD Long-Term Average for Direct Discharge (NSPS)--

COD is not applicable to the BAT regulation; however, it is proposed for regulation under NSPS and is judged to be equivalent to the BPT

limitation since the biological treatment recommended to remove this pollutant is common to both these regulations and BPT. The long-term average for COD is therefore 8.01 lbs/1,000 lbs, as shown in Table XV-21.

Priority Pollutant Long-Term Average for Indirect Discharge (PSES/PSNS)--

The selection of priority pollutant long-term averages for pretreatment standards was based on the same rationale as selection of long-term averages for effluent limitations. This rationale includes a review of effluents achieved and effluents achievable. For indirect dischargers, however, the effluents achievable were derived by utilizing such pretreatment as steam stripping, chemical oxidation, and metals separation.

The selected long-term averages for indirect discharge of priority pollutants is presented in Table XV-19.

Nonconventional Pesticides Long-Term Average for Indirect Discharge (PSES/PSNS)--

The process by which the nonconventional pesticide standards were derived included first, an evaluation of the effluent levels achievable for only those pesticides to be regulated in a given subcategory. Only achievable values for indirect dischargers utilizing pesticide removal were considered. Second, the maximum effluent achievable value for each subcategory was selected as the standard for that subcategory. Using the maximum effluent achievable for each subcategory ensures that all plants in the subcategory are capable of meeting the selected long-term average. Table XV-20 lists the long-term average effluents for nonconventional pesticides by subcategory. The selection of nonconventional pesticide standards is presented as follows by subcategory.

Subcategory 1--The highest effluent achievable value of 11 discrete indirect discharge pesticide processes was found to be 0.0302 lb/1,000 lbs (0.15 mg/l) for niacide at Plant 91 following pesticide removal. This value was therefore selected as the pesticide long-term average effluent for Subcategory 1. Based on available data, one pesticide process to be regulated in Subcategory 1 show that the selected long-term average effluent standard is not currently being achieved. No data are available for the other 10 indirect discharge pesticide processes.

Subcategory 2--The highest effluent achievable of 11 discrete indirect discharge pesticide processes was found to be 0.0938 lb/1,000 lbs (1.95 mg/l) for alachlor at Plant 100 following pesticide removal. This value was therefore selected as the pesticide long-term average effluent for Subcategory 2. Based on available data, the long-term average effluent is currently being achieved by three pesticides which are proposed for regulation.

Subcategory 3--The highest effluent achievable value of six discrete indirect discharge pesticide processes was found to be 0.0145 lb/1,000 lbs (0.15 mg/l) for ziram at Plant 151 following pesticide removal. This value was therefore selected as the pesticide long-term average effluent for Subcategory 3. There are no data available which document the effluent levels achieved for pesticides to be regulated in Subcategory 3.

Subcategory 4--Only one pesticide, fluometuron, is proposed to be regulated in Subcategory 4 for the pesticide parameter. Therefore, the pretreatment effluent achievable value of 0.00243 lb/1,000 lbs (0.0537 mg/l) for fluometuron at Plant 153 was selected as the long-term average effluent for this subcategory. Based on available data, Plant 153 is not currently achieving the selected pesticide long-term average.

Subcategory 5--The highest effluent achievable of two discrete indirect discharge pesticide processes was found to be 0.0182 lb/1,000 lbs (0.15 mg/l) for zineb at Plant 156 following pesticide removal. This value was therefore selected as the pesticide long-term average effluent of Subcategory 5. Based on available data, the long-term average effluent is not currently being achieved by pesticides which are proposed for regulation in this subcategory.

Subcategory 6--All pesticides listed in Subcategory 6 are not proposed for regulation due to lack of acceptable analytical methods and technical and economic data; therefore, no pesticide long-term average effluent has been selected.

Subcategory 7--All pesticides listed in Subcategory 7 are not proposed for regulation due to lack of acceptable analytical methods and technical and economic data; therefore, no pesticide long-term average effluent has been selected.

Subcategory 8--All pesticides in Subcategory 8 were regulated for the pesticide parameter during BPT for direct dischargers since the recommended treatment technology for pesticides is equal to adsorption or hydrolysis pretreatment for both the BPT direct dischargers and PSES/PSNS indirect dischargers; therefore, the pretreatment long-term average for PSES/PSNS is equal to the BPT long-term average of 0.00129 lb/1,000 lbs (0.0344 mg/l). Currently, there are no indirect discharge pesticides in Subcategory 8 which are being proposed for regulation.

Subcategory 9--All pesticides in Subcategory 9 were regulated for the pesticide parameter during BPT for direct dischargers since the recommended treatment technology for pesticides is equal to adsorption or hydrolysis pretreatment for both the BPT direct discharge and PSES/PSNS indirect dischargers; therefore, the pretreatment long-term average for PSES/PSNS is equal to the BPT long-term average of 0.00129 lb/1,000 lbs (0.0344 mg/l). Data from three pesticides to be regulated in Subcategory 9 show that the selected long-term average effluent is currently being achieved.

Subcategory 10--Since no indirect dischargers are proposed for regulation in this subcategory, the direct discharge highest pretreatment effluent achievable value was selected and was found to be 0.0583 lb/1,000 lbs (1.0 mg/l) for propazine at Plant 190 following pesticide removal. This value was therefore selected as the pesticide long-term average effluent for Subcategory 10.

Subcategory 11--All pesticides in Subcategory 11 are proposed for regulation to a zero discharge effluent standard since there is no discharge of pesticide process wastewater.

Subcategory 12--All metallo-organic pesticide manufacturers of mercury, cadmium, copper, and arsenic-based products which were not previously regulated under BPT are proposed for regulation to a zero discharge effluent standard. This proposal is based on the BPT direct discharge limitation of zero discharge and the fact that there is no process difference between direct and indirect discharge metallo-organic manufacturers.

Subcategory 13--All pesticide formulator/packagers which were not previously regulated under BPT are proposed for regulation to a zero discharge effluent standard. This proposal is based on the BPT direct discharge limitation of zero discharge and the fact that there is no process difference between direct and indirect discharge formulator/ packagers.

TREATMENT VARIABILITY

In the development of effluent limitations guidelines, the variability of daily and monthly average discharge levels must be considered. The derivation of variability factors is based on a statistical analysis of the effluent levels from plants with long-term data available. The purpose in deriving variability factors is to define daily and 30-day maximum levels for pollutant discharges which statistical evaluations predict can be achieved by well operated plants a high proportion of the time. The daily and 30-day maximum levels are determined by multiplying the daily and 30-day variability factors times the long-term average effluent discharge in pounds of pollutant per thousand pounds of product.

The data sets were initially reviewed to screen out data without adequate production and flow documentation. Subsequent screening resulted in excluding data which are unrepresentative of a properly designed and operated treatment system. Operating conditions such as adsorber breakthrough, stripper malfunction, and flow in excess of design were considered unrepresentative. Outliers were excluded from the statistical analysis.

Daily and monthly average effluent concentration values, provided by the plants, were converted to pounds per day for the analysis. The number of pollutants, plants, and observations available at this time are presented in Table XV-22.

The first step in the statistical analysis was to determine if the data could be assumed to fit a normal or log-normal distribution. For the daily and monthly data, goodness-of-fit tests were conducted using procedures derived by Shapiro-Wilk (Shapiro, 1965) and Kolmogorov-Smirnov (as modified by Stephens, 1974). For data sets consisting of 50 values or less, the Shapiro-Wilk test was used; for sets containing greater than 50 values, the modified Kolmogorov-Smirnov test was used. This convention was adopted because the Shapiro-Wilk procedure has high power for small samples, but requires extensive tables to determine significance levels (see Stephens, 1974, for details). The modified Kolomogrov-Smirnov test has good power for large samples, and approximate significance levels can be calculated without tables.

The results of the tests indicate that, with one possible exception, the daily data consistently failed the tests for normality/log-normality at a 5 percent level of significance. Therefore, three other methods of estimating variability were investigated based on nonparametric, partially nonparametric, and delta distribution techniques. The non-parametric method of analysis makes no restrictive assumptions regarding the distributional form of the data set, and can be used to predict effluent loadings in a manner completely analagous to that which would be used if the data fit a particular distribution such as the normal or lognormal. Therefore a nonparametric method was chosen to estimate the variability (Gibbons, 1971).

Several data sets contained data reported to be less than the detection limit. For these data it was necessary to assume a real value. Three alternatives were considered for such cases: (1) assign these data values of the detection limit, (2) assign these data values of one-half the detection limit, and (3) assign these data values of zero. A decrease in the assigned value results in a corresponding decrease in the mean and increase in the variability. Statistical analyses were made of each alternative but the first alternative, assigning these data values of the detection limit, was chosen for use in calculating the daily and monthly limitations because this technique is familiar to the industry since it was previously used during the pesticide BPT regulation.

Daily Variability Factors

The daily maximum variability factor is defined as an estimate (U_k) of the 99th percentile of the daily pollutant discharge divided by the average daily pollutant discharge. This estimate is obtained by using the following binomial equation to establish the value of k such that U_k has a probability of at least 50 percent of exceeding the 99th percentile of the distribution of daily discharges.

$$\text{Confidence coefficient} = 1 - \sum_{j-0}^{k-1} \binom{N}{(j)} (0.01)^{j} (0.99)^{N-j}$$

where k = rank of each observation
N = total number of values available

U_k therefore represents a value below which at least 99 percent of the values of a future samples of size N will fall at least 50 percent of the time. The daily variability factor is then calculated by the equation

$$VF_d = \frac{U_k}{\overline{x}}$$

where U_k = the observation used to estimate the 99th percentile which has a confidence coefficient most closely approximating, but not less than, 50 percent.

$\overline{x}$ = arithmetic average of the daily observations

Daily variability factors were calculated on 7 priority pollutant data sets of sample sizes greater than 56 data points and on 7 nonconventional pollutant pesticides of sample sizes greater than 79 data points.

The results of this analysis for each of the available plant/pollutant data sets are presented in Table XV-22.

30-Day Variability Factors

The monthly average variability factor is defined as the estimate of the 99th percentile of the average monthly pollutant discharge divided by the average monthly pollutant discharge. The estimated 99th percentile of the monthly averages, based on daily values, is derived from the equation

$$M_d = \overline{x} + 2.33s\sqrt{\frac{1}{m}}$$

where m = number of sample days/month to which the maximum is applied
s = standard deviation of the daily observations
$\overline{x}$ = arithmetic average of the daily observations

This equation assumes the approximate normality of the monthly average. When the monthly average consists of a sufficient number of daily observations, the central limit theorem assures their normality. What represents a sufficient number of observations varies according to the underlying distribution of the data.

For data reported as monthly averages (where all monthly averages consist of 30 observations), the daily standard deviation may be approximated by $\sqrt{30}\ s_{\overline{x}}$ where $s_{\overline{x}}$ is the standard deviation of the monthly averages. Therefore the equation for the estimated 99th percentile of the monthly averages, based on monthly values, becomes

$$M_m = \overline{\overline{x}} + 2.33 \sqrt{30}\ s_{\overline{x}} \sqrt{1/m}$$

where $s_{\overline{x}}$ = standard deviation of the monthly averages
$\overline{\overline{x}}$ = arithmetic average of monthly averages

The resulting estimate represents an estimate of the 99th percentile of the monthly averages assuming that:

1. The observations are statistically independent,

2. The number of days sampled per month is large enough to warrant the use of the Central Limit Theorem to assure approximate normality of the monthly means,

3. The number of observations used to compute each monthly average is equal to 30 if M_m is being calculated.

The monthly variability factor is then calculated by the following equations depending on whether monthly or daily data are available.

$$VF_m = \frac{M_d}{\overline{x}} \text{ or } \frac{M_m}{\overline{\overline{x}}}$$

Monthly variability factors were calculated on both monthly average data and on daily data. The monthly variability factors, based on monthly averages, were calculated on 5 priority pollutants with sample sizes of at least 12 data points. The monthly variability factors, based on daily data, were calculated on 7 priority pollutants of sample sizes greater than 56 data points and on 7 nonconventional pollutant pesticides of sample sizes greater than 79 data points.

The results of this analysis for each of the available plant/pollutant data sets are presented in Table XV-22.

The monthly average variability factors shown on this table are based on a sampling schedule of 30 days per month.

Application of Variability Factors

There were insufficient data available for the statistical analysis of each pesticide and priority pollutant to be regulated. A mechanism by which variability factors could be combined and transferred was therefore developed. The following criteria were established for the assignment of variability factors to each priority pollutant to be regulated.

1. Variability factors calculated for a priority pollutant, other than priority pollutant pesticides, were applied to that priority pollutant.

2. Where variability factors were not available for a priority pollutant other than priority pollutant

pesticides, variability factors from other priority pollutants from the same pollutant group were applied.

3. Where variability factors were not available for any priority pollutant within the pollutant group other than priority pollutant pesticides, variability factors from similar priority pollutant groups were applied.

4. For priority pollutant pesticides, the pesticide BPT variability factors of 7.6 (daily) and 1.4 (monthly) were applied to the priority pollutant pesticide compounds.

5. The following pesticide BPT and metal transfer technology variability factors were applied to the conventional pollutants BOD and TSS, the nonconventional pollutant COD, and the metal zinc.

	Daily Variability Factor	Monthly Variability Factor
BOD	6.6	1.4
TSS	4.7	1.3
COD	1.6	1.2
Zinc	3.00	1.30

In cases where more than one variability factor was available, a weighted average variability factor was calculated and applied based on the number of data points available.

The following criteria were established for the assignment of variability factors to nonconventional pesticides to be regulated.

1. The variability factors calculated for a pesticide within a pesticide subcategory were applied to that pesticide and all other pesticides in that subcategory.

2. In cases where more than one variability factor was available, the average variability factor, weighted based on the number of data points, was applied to all pesticides in the subcategory.

3. Where variability factors were not available for any pesticide within a pesticide subcategory, the pesticide BPT variability factor was applied to all pesticides in that subcategory.

EFFLUENT LIMITATIONS AND PRETREATMENT STANDARDS

BAT

BAT effluent limitations guidelines for direct dischargers are presented in Tables II-7 through II-19.

NSPS

NSPS effluent limitations guidelines for direct dischargers are presented in Tables II-20 through II-32.

PSES and PSNS

PSES and PSNS pretreatment standards guidelines for indirect dischargers are presented in Tables II-33 through II-45.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS

PESTICIDES

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01-D	0.00602	0.0381	(24)
B1	2/01-D	0.002	0.0000214	(5)
C1	3/01-D	<0.01	<0.00871	(1)
D1	4/01-D	0.01	0.0017	(5)
E1	5/01	<0.023*	<0.00016*	(14)
F1	6/01-D	<0.025	<0.0000159	(3)
G1	7/01	<0.0394	<0.570	(26)
H1	8/01	<0.050	<0.0289	(1)
I1	9/01	<0.10	<0.00574	(1)
J1	10/01	0.101	0.124	(7)
K1	11/01	<0.112	<0.478	(6)
L1	12/01	<0.2	<0.174	(NA)
M1	13/01-D	<0.342	<0.30	(4)
N1	14/01-D	0.362*	NA	(11)
O1	15/01-D	0.378*	0.317*	(19)
P1	16/01-D	0.807*	0.228*	(3)
Q1	17/01-D	<0.92	<0.555	(221)
R1	18/01	1.58	1.75	(6)
S1	19/01-D	3.37	0.00411	(163)
T1	20/01	5.52	0.0961	(82)
U1	21/01	10.0	0.57	(E)
V1	22/01-P	15.2	1.22	(147)
W1	23/01	50.0	0.0448	(E)
A1	1/02	ND	NA	(E)
B1	2/02	ND	NA	(E)
C1	3/02	ND	NA	(1)
D1	4/02	<0.00010	0.0014	(3)
E1	5/02	0.000953	0.00124	(29)
F1	6/02-D	0.002	0.0000559	(7)
G1	7/02	0.008	0.0076	(20)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
(E) = Plant estimate.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

PESTICIDES (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
H1	8/02-P	<0.0084	<0.00102	(3)
I1	9/02-D	<0.01*	<0.0026*	(1)
J1	10/02	<0.010	<0.00474	(3)
K1	11/02	<0.010	<0.0318	(3)
L1	12/02	<0.010	<0.0405	(3)
M1	13/02	0.011	0.000546	(3)
N1	14/02	0.012	0.0114	(20)
O1	15/02	0.012	0.0029	(61)
P1	16/02-P	<0.0186	<0.00321	(59)
Q1	17/02	<0.0197	<0.0683	(33)
R1	18/02-D	<0.027	<0.205	(10)
S1	19/02	0.0452*	0.00293*	(40)
T1	20/02	<0.05	<0.0752	(1)
U1	21/02	0.0554	0.0827	(3)
V1	22/02-D	<0.067	<0.0850	(105)
W1	23/02-D	0.08*	0.0665*	(1)
X1	24/02	<0.081*	<0.09*	(208)
Y1	25/02	<0.081*	<0.09*	(208)
Z1	26/02	<0.081*	<0.09*	(208)
A2	27/02-D	<0.0836	<0.40	(21)
B2	28/02	0.09	0.0054	(E)
C2	29/02	<0.105	<0.187	(59)
D2	30/02-D	<0.148	<0.604	(16)
E2	31/02	0.164	0.36	(2)
F2	32/02-D	0.170	0.1615	(1)
G2	33/02	0.184	0.0502	(3)
H2	34/02	<0.20	<0.245	(1)
I2	35/02	0.255	1.03	(14)
J2	36/02	<0.279	<0.562	(6)
K2	37/02	0.35	0.00549	(8)
L2	38/02-P	0.350*	0.0213*	(2)
M2	39/02-D	0.362	NA	(5)
N2	40/02-D	0.378	0.317	(19)
O2	41/02	<0.5	<0.0179	(1)
P2	42/02	<0.533	<0.961	(109)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
NA = Not available.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

PESTICIDES (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
Q2	43/02-D	0.807*	0.228*	(3)
R2	44/02	<1.0	<0.71	(1)
S2	45/02-D	1.26	0.031	(5)
T2	46/02-D	1.37	0.041	(E)
U2	47/02	2.08	1.34	(365)
V2	48/02	<1.62	<1.05	(74)
W2	49/02	1.667	1.43	(3)
X2	50/02	2.00	0.20	(E)
Y2	51/02	3.20	3.71	(3)
Z2	52/02-D	5.0	0.0367	(3)
A3	53/02-P	<9.24	<0.238	(140)
B3	54/02	10.3	0.556	(365)
C3	55/02	15.3	16.6	(22)
D3	56/02-P	<18.3	<0.291	(156)
E3	57/02	114.0	12.2	(274)
A1	1/04	<0.00183	<0.00392	(12)
B1	2/04	0.0452*	0.00293*	(40)
C1	3/04	<27.0	<30.5	(55)
D1	4/04	60.0	NA	(1)
E1	5/04-D	<314.0	<44.0	(4)
A1	1/05	ND	NA	(12)
B1	2/05	<0.10	<0.00106	(1)
C1	3/05-D	<0.254	<0.329	(21)
D1	4/05-P	0.350*	0.0213*	(2)
E1	5/05-P	0.350*	0.0213*	(2)
A1	1/08-D	<0.0013**	<0.000220**	(3)
B1	2/08-D	<0.0048**	<0.0034**	(217)
C1	3/08-D	0.005**	0.0035**	(137)
D1	4/08-D	0.0093	0.00031	(18)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
** = Final plant effluent.
(E) = Plant estimate.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

PESTICIDES (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
E1	5/08-P	<0.01*	<0.00066*	(606)
F1	6/08-P	<0.01*	<0.00066*	(606)
G1	7/08-D	0.0169	0.000645	(85)
H1	8/08-D	0.0713††	0.000223††	(3)
I1	9/08-D	0.468††	0.00123††	(420)
J1	10/08-D	2.82††	0.017††	(26)
A1	1/09-D	<0.00010	<0.00094	(3)
B1	2/09-D	0.00067	0.0000060	(3)
C1	3/09-D	<0.001	<0.0000019	(2)
D1	4/09-D	0.00123	0.00000974	(84)
E1	5/09-D	0.00149	0.000437	(3)
F1	6/09-D	0.00175	0.000724	(684)
G1	7/09-D	0.005	0.001	(4)
H1	8/09-D	0.0055	0.0016	(154)
I1	9/09-D	0.01	0.002	(40)
J1	10/09-P	<0.010	<0.00013	(3)
K1	11/09-P	0.010	0.00081	(174)
L1	12/09-P	<0.015	<0.0016	(171)
M1	13/09-D	0.0182	0.0000765	(25)
N1	14/09	<0.023*	<0.00016*	(14)
O1	15/09-P	0.024	0.028	(3)
P1	16/09-P	0.0428	0.00117	(3)
Q1	17/09-P	0.059	0.089	(3)
R1	18/09-D	<0.0685	<0.0274	(75)
S1	19/09-D	<0.0946	<0.129	(129)
T1	20/09-P	<0.0984*	<0.00290*	(63)
U1	21/09	<0.1	<0.281	(1)
V1	22/09	<0.5	<0.25	(1)
W1	23/09	<0.50	NA	(1)
X1	24/09	0.783	0.675	(3)
Y1	25/09	0.783	0.675	(3)
Z1	26/09-P	11.0	0.0107	(17)
A2	27/09-P	18.6	0.314	(265)
B2	28/09	2.14	0.0385	(4)
C2	29/09	2.19	0.0394	(4)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
NA = Not available.
* = Data from comingled pesticide streams.
†† = After pretreatment.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

PESTICIDES (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
D2	30/09-P	<19.5	<0.373	(352)
E2	31/09-P	24.0	0.472	(3)
F2	32/09	32.3	0.296	(1)
G2	33/09	49.7	0.344	(1)
H2	34/09	66.5	0.623	(1)
I2	35/09	190°	0.215°	(2)
J2	36/09	330	53.1	(3)
K2	37/09-P	2.14	0.0385	(4)
A1	1/10	<0.01	<0.0210	(24)
B1	2/10-D	<0.10	<0.00267	(3)
C1	3/10-D	<0.012	<0.00017	(153)
D1	4/10-D	<0.49	<0.234	(81)
E1	5/10-D	0.68	0.3	(4)
F1	6/10	<4.17	<1.26	(22)
G1	7/10	<4.19	<1.56	(29)
H1	8/10	<4.31	<2.35	(27)
I1	9/10	<4.67	<1.09	(9)
J1	10/10-D	4.7*	0.185*	(270)
K1	11/10-D	4.7*	0.185*	(270)
L1	12/10-D	4.7*	0.185*	(270)
M1	13/10	<5.37	<1.15	(42)
N1	14/10-D	<5.84	<1.81	(154)
O1	15/10-D	12.4*	0.479*	(E)
P1	16/10-D	12.4*	0.479*	(E)
Q1	17/10-D	12.4*	0.479*	(E)
R1	18/10	<14.5	<5.65	(28)
S1	19/10	<18.4	<3.65	(87)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
° = o,p' and p,p' DDT.
(E) = Plant estimate.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

COD

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	31.2	NA	(5)
B1	2/01	<50.0†	<1.42†	(11)
C1	3/01-D	<60.3†	<1.23†	(3)
D1	4/01-D	<336†	<86.9†	(1)
E1	5/01-D	<336†	<86.9†	(1)
F1	6/01-W	<515*	<51.4*	(46)
G1	7/01-D	<519†	<134†	(3)
H1	8/01-D	<519†	<134†	(3)
I1	9/01-D	<770°†	<73.0°†	(1)
J1	10/01	808*	25.5*	(5)
K1	11/01	819*	152*	(3)
L1	12/01-D	<1,280†	<59.7†	(444)
M1	13/01	9,500*	54.3*	(E)
N1	14/01	9,500*	54.3*	(E)
O1	15/01	9,500*	54.3*	(E)
P1	16/01	13,100*	437*	(3)
Q1	17/01	13,100*	437*	(3)
R1	18/01	14,400	2,700	(1)
S1	19/01	18,900*	214*	(12)
T1	20/01	150,000*	109*	(1)
U1	21/01	150,000*	109*	(1)
A1	1/02	14.0*	0.00113*	(1)
B1	2/02	14.0*	0.00113*	(1)
C1	3/02-D	<60.3†	<1.23†	(3)
D1	4/02-D	160*	5.89*	(365)
E1	5/02-D	160*	5.89*	(365)
F1	6/02-D	160*	5.89*	(365)
G1	7/02-D	<290†	<77.3	(3)
H1	8/02-D	<290†	<77.3	(3)
I1	9/02-D	299*	19.4*	(28)
J1	10/02-D	<336†	<86.9†	(1)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
W = Deep well injection of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Pilot plant data.
(E) = Plant estimate.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

COD (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
K1	11/02	360	26.9	(449)
L1	12/02-P	<394†	<9.25†	(1,166)
M1	13/02-D	<515*	<51.4*	(46)
N1	14/02-D	<515*	<51.4*	(46)
O1	15/02-D	<515*	<51.4*	(46)
P1	16/02-D	<519†	<134†	(3)
Q1	17/02	808*	25.5*	(5)
R1	18/02-D	<1,280†	<59.7†	(444)
S1	19/02-D	<1,280†	<59.7†	(444)
T1	20/02-D	<1,280†	<59.7†	(444)
U1	21/02-D	<1,280†	<59.7†	(444)
V1	22/02-D	<2,320†	<41.1†	(3)
W1	23/02-D	<2,320†	<41.1†	(3)
X1	24/02	2,580*	31.9*	(3)
Y1	25/02	3,711	52.2	(30)
Z1	26/02	150,000*	109*	(1)
A2	27/02	150,000*	109*	(1)
B2	28/02	150,000*	109*	(1)
A1	1/04-D	299*	19.4*	(28)
B1	2/04	9,500*	54.3*	(E)
A1	1/05-D	<1,280†	<59.7†	(444)
A1	1/08-P	127*	7.94*	(450)
B1	2/08-P	127*	7.94*	(450)
C1	3/08	2,880	9.51	(3)
D1	4/08-D	3,390	129	(375)
E1	5/08	150,000*	109*	(1)
A1	1/09	200*	131*	(3)
B1	2/09	200*	131*	(3)
C1	3/09	204	0.37	(3)
D1	4/09-D	<290†	<77.3†	(3)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(E) = Plant estimate.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

COD (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
E1	5/09-D	<290†	<77.3†	(3)
F1	6/09	576	4.60	(3)
G1	7/09	819*	152*	(3)
H1	8/09-D	<1,280†	<59.7†	(444)
I1	9/09-D	<1,280†	<59.7†	(444)
J1	10/09-D	<2,320†	<41.1†	(3)
K1	11/09	2,580*	31.9*	(3)
L1	12/09	2,580*	31.9*	(3)
M1	13/09	18,900*	214*	(12)
N1	14/09	109,000	NA	(6)
A1	1/10	<285*	<11.2*	(270)
B1	2/10	<285*	<11.2*	(270)
C1	3/10	<285*	<11.2*	(270)
D1	4/10-D	420*	32.2*	(540)
E1	5/10-D	420*	32.2*	(540)
F1	6/10-D	420*	32.2*	(540)
G1	7/10-D	537	14.0	(3)
H1	8/10	819*	152*	(3)
I1	9/10-D	890	26.9	(1)
J1	10/10-D	<2,320†	<41.1†	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

TOC

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	15.4	NA	(5)
B1	2/01-D	<100†	<25.8†	(1)
C1	3/01-D	<100†	<25.8†	(1)
D1	4/01-D	<136†	<35.2†	(3)
E1	5/01-D	<136†	<35.2†	(3)
F1	6/01	153*	4.82*	(5)
G1	7/01	<245†	NA	(19)
H1	8/01	2,000*	373*	(1)
I1	9/01	5,850*	66.2*	(12)
J1	10/01	50,000*	36.4*	(1)
K1	11/01	50,000*	36.4*	(1)
A1	1/02-D	<100†	<25.8†	(1)
B1	2/02-D	104*	6.74*	(34)
C1	3/02-D	<136†	<35.2†	(3)
D1	4/02	153*	4.82*	(5)
E1	5/02	2,000*	373*	(1)
F1	6/02	50,000*	36.4*	(1)
G1	7/02	50,000*	36.4*	(1)
H1	8/02	50,000*	36.4*	(1)
A1	1/04-D	104*	6.74*	(34)
B1	2/04	165	35.1	(455)
A1	1/05	2,000*	373*	(1)
A1	1/08	50,000*	36.4*	(1)
A1	1/09	40.3	0.072	(3)
B1	2/09	59.0	0.50	(3)
C1	3/09	105*	68.4*	(3)
D1	4/09	105*	68.4*	(3)
E1	5/09	2,590	33.9	(3)
F1	6/09	5,850*	66.2*	(12)
G1	7/09	66,700	NA	(6)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

TOC (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/10	81.0*	<3.19*	(270)
B1	2/10	81.0*	<3.19*	(270)
C1	3/10	81.0*	<3.19*	(270)
D1	4/10-D	126*	9.66*	(540)
E1	5/10-D	126*	9.66*	(540)
F1	6/10-D	126*	9.66*	(540)

D = Direct discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

Table XV-1. Effluent Levels Achieved

NONCONVENTIONAL PARAMETERS (Continued)

TOD

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01-D	<408†	<35.9†	(246)
A1	1/02-D	<408†	<35.9†	(246)
B1	2/02-D	<408†	<35.9†	(246)
C1	3/02	<408†	<35.9†	(246)
D1	4/02-D	<3,094†	<42.7†	(743)
E1	5/02-D	<3,094†	<42.7†	(743)
A1	1/03-D	<408†	<35.9†	(246)
A1	1/04-D	<3,094†	<42.7†	(743)
A1	1/09	<408†	<35.9†	(246)
B1	2/09	<408†	<35.9†	(246)
C1	3/09-D	<3,094†	<42.7†	(743)
A1	1/10-D	<3,094†	<42.7†	(743)
B1	2/10-D	<3,094†	<42.7†	(743)
C1	3/10-D	<3,094†	<42.7†	(743)
D1	4/10-D	<3,094†	<42.7†	(743)
E1	5/10-D	<3,094†	<42.7†	(743)
F1	6/10-D	<3,094†	<42.7†	(743)
G1	7/10-D	<3,094†	<42.7†	(743)

D = Direct discharge of wastewater after recommended treatment.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-2. Effluent Levels Achieved

CONVENTIONAL PARAMETERS

BOD

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01-D	<1.0†	<0.0204†	(3)
B1	2/01	<1.92	<0.00126	(3)
C1	3/01-D	8.0†	2.98†	(3)
D1	4/01-D	<50.0°†	<4.74°†	(1)
E1	5/01-D	<73.6†	<3.44†	(171)
F1	6/01-W	<74.3*	<7.28*	(42)
G1	7/01-D	<114†	<29.5†	(3)
H1	8/01-D	<114†	<29.5†	(3)
I1	9/01-D	<253*	<1.74*	(3)
J1	10/01	319*	59.0*	(3)
K1	11/01	889*	28.0*	(5)
L1	12/01	6,600*	74.7*	(12)
M1	13/01	6,000*	43.7*	(1)
N1	14/01	16,000	300	(1)
O1	15/01	60,000*	43.7*	(1)
A1	1/02	<1.0†	<0.0204†	(3)
B1	2/02-D	<7.0†	1.87†	(4)
C1	3/02-D	<7.0†	1.87†	(4)
D1	4/02-D	8.0†	2.98†	(3)
E1	5/02-D	8.0†	2.98†	(3)
F1	6/02-D	8.0†	2.98†	(3)
G1	7/02-D	8.0†	2.98†	(3)
H1	8/02-D	8.0†	2.98†	(3)
I1	9/02-D	8.0†	2.98†	(3)
J1	10/02-D	8.0†	2.98†	(3)
K1	11/02-D	12.2*	0.438*	(202)
L1	12/02-D	12.2*	0.438*	(202)
M1	13/02-D	12.2*	0.438*	(202)
N1	14/02-D	15.3*	0.708*	(103)
O1	15/02-D	39.0*	2.53*	(34)
P1	16/02-D	<73.6†	<3.44†	(171)
Q1	17/02-D	<73.6†	<3.44†	(171)
R1	18/02-D	<73.6†	<3.44†	(171)

D = Direct discharge of wastewater after recommended treatment.
W = Deep well injection of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Pilot plant data.
(n) = Number of data points available.

Table XV-2. Effluent Levels Achieved

CONVENTIONAL PARAMETERS (Continued)

BOD (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
S1	19/02-D	<73.6†	<3.44†	(171)
T1	20/02-D	<74.3*	<7.28*	(42)
U1	21/02-D	<74.3*	<7.28*	(42)
V1	22/02-D	<74.3*	<7.28*	(42)
W1	23/02-D	<96.5†	<1.71†	(3)
X1	24/02-D	<96.5†	<1.71†	(3)
Y1	25/02-D	114†	<29.5†	(2)
Z1	26/02-D	<122†	<1.68†	(762)
A2	27/02-D	<122†	<1.68†	(762)
B2	28/02	889*	28.0*	(5)
C2	29/02	4,136*	51.2*	(3)
D2	30/02	60,000*	43.7*	(1)
E2	31/02	60,000*	43.7*	(1)
F2	32/02	60,000*	43.7*	(1)
A1	1/04-D	15.3*	0.708*	(103)
B1	2/04-D	39.0*	2.53*	(34)
C1	3/04-D	<122†	<1.68†	(762)
A1	1/05-D	<73.6†	<3.44†	(171)
A1	1/08-P	12.7*	0.791*	(450)
B1	2/08-P	12.7*	0.791*	(450)
C1	3/08	316	1.02	(3)
D1	4/08-D	1,820	69.4	(85)
E1	5/08	60,000*	43.7*	(1)
A1	1/09-D	<7.0†	<1.87†	(4)
B1	2/09-D	<7.0†	<1.87†	(4)
C1	3/09-D	8.0†	2.98†	(3)
D1	4/09	54.1*	35.4*	(3)
E1	5/09	54.1*	35.4*	(3)
F1	6/09	55.0	0.47	(3)
G1	7/09-D	<73.6†	<3.44†	(171)
H1	8/09-D	<73.6†	<3.44†	(171)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-2. Effluent Levels Achieved

CONVENTIONAL PARAMETERS (Continued)

BOD (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
I1	9/09-D	<96.5†	<1.71†	(3)
J1	10/09-D	<122†	<1.68†	(762)
K1	11/09-D	<253*	<1.74*	(1)
L1	12/09	319*	59.0*	(3)
M1	13/09	2,104	27.5	(3)
N1	14/09	4,136*	51.2*	(3)
O1	15/09	4,136*	51.2*	(3)
P1	16/09	6,600*	74.7*	(12)
Q1	17/09	37,400	NA	(6)
A1	1/10	<20.0*	<0.787*	(270)
B1	2/10	<20.0*	<0.787*	(270)
C1	3/10	<20.0*	<0.787*	(270)
D1	4/10-D	29.6	0.772	(3)
E1	5/10-D	48.9*	3.75*	(540)
F1	6/10-D	48.9*	3.75*	(540)
G1	7/10-D	48.9*	3.75*	(540)
H1	8/10-D	78.8	2.37	(1)
I1	9/10-D	<96.5†	<1.71†	(3)
J1	10/10-D	<122†	<1.68†	(762)
K1	11/10-D	<122†	<1.68†	(762)
L1	12/10-D	<122†	<1.68†	(762)
M1	13/10-D	<122†	<1.68†	(762)
N1	14/10-D	<122†	<1.68†	(762)
O1	15/10-D	<122†	<1.68†	(762)
P1	16/10-D	<122†	<1.68†	(762)
Q1	17/10	319*	59.0*	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-2. Effluent Levels Achieved

CONVENTIONAL PARAMETERS (Continued)

TSS

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	<5.0	<0.00329	(3)
B1	2/01-D	<27.3†	<7.10†	(3)
C1	3/01-D	<27.3†	<7.10†	(3)
D1	4/01	32.3	2.59	(148)
E1	5/01-D	<35.0†	<0.714†	(3)
F1	6/01	35.0*	6.50*	(3)
G1	7/01-D	39.0†	14.5	(3)
H1	8/01	46.6*	1.47*	(5)
I1	9/01-D	<64.0†	<16.5†	(1)
J1	10/01-D	<64.0†	<16.5†	(1)
K1	11/01-D	<68.5†	<3.2†	(455)
L1	12/01-W	<81.2*	<8.72*	(46)
M1	13/01-D	92.0°	8.72°	(1)
N1	14/01-D	<117†	NA	(1)
A1	1/02-D	<0.69†	<0.184	(3)
B1	2/02-D	<0.69†	<0.184	(3)
C1	3/02	2.0*	0.000162*	(1)
D1	4/02	2.0*	0.000162*	(1)
E1	5/02	3.2†	<3.0†	(23)
F1	6/02	3.2†	<3.0†	(23)
G1	7/02	3.2†	<3.0†	(23)
H1	8/02-D	18.0*	1.17*	(28)
I1	9/02-D	22.8*	1.05*	(102)
J1	10/02-D	<27.3†	<7.10†	(3)
K1	11/02-D	28.4*	0.983*	(365)
L1	12/02-D	28.4*	0.983*	(365)
M1	13/02-D	28.4*	0.983*	(365)
N1	14/02-D	<35.0†	<0.714†	(3)
O1	15/02-D	39.0†	14.5	(3)
P1	16/02-D	39.0†	14.5	(3)
Q1	17/02-D	39.0†	14.5	(3)
R1	18/02-D	39.0†	14.5	(3)
S1	19/02-D	39.0†	14.5	(3)
T1	20/02-D	39.0†	14.5	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
W = Deep well injection of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Pilot plant data.
(n) = Number of data points available.

Table XV-2. Effluent Levels Achieved

CONVENTIONAL PARAMETERS (Continued)

TSS (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
U1	21/02-D	39.0†	14.5	(3)
V1	22/02	46.6*	1.47*	(5)
W1	23/02-D	<50.1†	<0.888†	(3)
X1	24/02-D	<50.1†	<0.888†	(3)
Y1	25/02-D	<64.0†	<16.5†	(1)
Z1	26/02-D	<66.8†	<0.923†	(532)
A2	27/02-D	<66.8†	<0.923†	(532)
B2	28/02	<68.5†	<3.20†	(455)
C2	29/02	<68.5†	<3.20†	(455)
D2	30/02	<68.5†	<3.20†	(455)
E2	31/02	<68.5†	<3.20†	(455)
F2	32/02	78.0	1.09	(30)
G2	33/02-D	<81.2*	<8.72*	(46)
H2	34/02-D	<81.2*	<8.72*	(46)
I2	35/02-D	<81.2*	<8.72*	(46)
J2	36/02	185*	2.29*	(3)
A1	1/04-D	18.0*	1.17*	(28)
B1	2/04-D	22.8*	1.05*	(102)
C1	3/04-D	<66.8†	<0.923†	(523)
A1	1/05	<68.5†	<3.2†	(455)
A1	1/08-P	20.8*	1.30*	(360)
B1	2/08-P	20.8*	1.30*	(360)
C1	3/08	34.0	0.111	(3)
D1	4/08-D	501	19.1	(1)
E1	5/08	29,600†	<1,720†	(1)
A1	1/09-D	<0.69†	<0.184	(3)
B1	2/09-D	<0.69†	<0.184	(3)
C1	3/09	19.0	0.15	(3)
D1	4/09	35.0*	6.50*	(3)
E1	5/09-D	39.0†	14.5	(3)
F1	6/09-D	<50.1†	<0.888†	(3)
G1	7/09-D	<66.8†	<0.923†	(532)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-2. Effluent Levels Achieved

CONVENTIONAL PARAMETERS (Continued)

TSS (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
H1	8/09	<68.5†	<3.20†	(455)
I1	9/09	<68.5†	<3.20†	(455)
J1	10/09	150	0.290	(3)
K1	11/09	185*	2.29*	(3)
L1	12/09	185*	2.29*	(3)
M1	13/09	280*	183*	(3)
N1	14/09	280*	183*	(3)
O1	15/09	2,600	NA	(6)
A1	1/10	25.7*	<1.01*	(270)
B1	2/10	25.7*	<1.01*	(270)
C1	3/10	25.7*	<1.01*	(270)
D1	4/10	35.0*	6.50*	(3)
E1	5/10-D	<50.1†	<0.888†	(3)
F1	6/10-D	<66.8†	<0.923†	(532)
G1	7/10-D	<66.8†	<0.923†	(532)
H1	8/10-D	<66.8†	<0.923†	(532)
I1	9/10-D	<66.8†	<0.923†	(532)
J1	10/10-D	<66.8†	<0.923†	(532)
K1	11/10-D	<66.8†	<0.923†	(532)
L1	12/10-D	<66.8†	<0.923†	(532)
M1	13/10-D	101	2.63	(3)
N1	14/10-D	140*	10.7*	(17)
O1	15/10-D	140*	10.7*	(17)
P1	16/10-D	140*	10.7*	(17)
Q1	17/10-D	178	5.37	(1)

D = Direct discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-3. Effluent Levels Achieved

VOLATILE AROMATICS

BENZENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02	ND	NA	(3)
B1	2/02	<0.010†	<0.00482†	(4)
C1	3/02	<0.010†	<0.000179†	(3)
D1	4/02	<0.010†	<0.00482†	(4)
E1	5/02	<0.010†	<0.00482†	(4)
F1	6/02	<0.010†	<0.00482†	(4)
G1	7/02	<0.010†	<0.00482†	(4)
H1	8/02	<0.010†	<0.00482†	(4)
I1	9/02-D	0.16†	0.0454†	(1)
A1	1/05-D	0.16†	0.0454†	(1)
A1	1/08	0.0050*	0.000312*	(1)
B1	2/08	0.0050*	0.000312*	(1)
A1	1/09	<0.010†	<0.00482†	(4)
B1	2/09	<0.010*	<0.00013*	(3)
C1	3/09	<0.010†	<0.000179†	(3)
D1	4/09	<0.012	<0.000060	(3)
E1	5/09	<0.032	<0.00019	(3)
F1	6/09-D	0.16†	0.0454†	(1)
A1	1/10	<0.010†	<0.000179†	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-3. Effluent Levels Achieved

VOLATILE AROMATICS (Continued)

TOLUENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	<0.007†	<0.00043†	(1)
B1	2/01	<9.6	<0.15	(48)
A1	1/02	ND†	NA	(3)
B1	2/02	ND	NA	(3)
C1	3/02	<0.007†	<0.00043†	(1)
D1	4/02	<0.010†	<0.00512†	(4)
E1	5/02	<0.010†	<0.000179†	(3)
F1	6/02	<0.010†	<0.00512†	(4)
G1	7/02	<0.010†	<0.00512†	(4)
H1	8/02	<0.010†	<0.00512†	(4)
I1	9/02	<0.01†	<0.0081†	(3)
J1	10/02	<0.010†	<0.0142†	(1)
K1	11/02-D	0.021*	0.00596*	(1)
L1	12/02-P	<79.6*°	<1.30*°	(318)
M1	13/02-P	<79.6*°	<1.30*°	(318)
N1	14/02-P	<79.6*°	<1.30*°	(318)
A1	1/05-D	0.021*	0.00596*	(1)
A1	1/08	0.009*	0.000562*	(1)
B1	2/08	0.009*	0.000562*	(1)
A1	1/09	ND*	NA	(3)
B1	2/09	ND†	NA	(3)
C1	3/09	<0.006	<0.00003	(3)
D1	4/09	<0.010†	<0.00512†	(4)
E1	5/09	<0.010†	<0.000179†	(3)
F1	6/09	<0.010†	<0.0142†	(1)
G1	7/09	<0.01†	<0.0081†	(3)
H1	8/09-P	0.0194*	0.00024*	(3)
I1	9/09-D	0.021*	0.00596*	(1)
J1	10/09-P	5.73	0.103	(4)
K1	11/09-P	21.9°	0.394°	(4)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Prior to final treatment step.
(n) = Number of data points available.

Table XV-3. Effluent Levels Achieved

VOLATILE AROMATICS (Continued)

TOLUENE (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
L1	12/09	28.5*	2.38*	(1)
M1	13/09	28.5*	2.38*	(1)
N1	14/09	28.5*	2.38*	(1)
A1	1/10	<0.01†	<0.000179†	(3)
B1	2/10	<0.1*	<0.0039*	(270)
C1	3/10	<0.1*	<0.0039*	(270)
D1	4/10	<0.1*	<0.0039*	(270)
E1	5/10	1.77*	0.136*	(540)
F1	6/10	1.77*	0.136*	(540)
G1	7/10	1.77*	0.136*	(540)

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-3. Effluent Levels Achieved

VOLATILE AROMATICS (Continued)

CHLOROBENZENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02	ND†	NA	(3)
B1	2/02	<0.010†	<0.00474†	(4)
C1	3/02	<0.010†	<0.00474†	(4)
D1	4/02	<0.010†	<0.00474†	(4)
E1	5/02	<0.010†	<0.00474†	(4)
F1	6/02	<0.01†	<0.00474†	(4)
G1	7/02	<0.01†	<0.00474†	(4)
H1	8/02	<0.081*°	<0.090*°	(208)
I1	9/02	<0.081*°	<0.090*°	(208)
J1	10/02	<0.081*°	<0.090*°	(208)
A1	1/08	0.76*	0.0474*	(1)
B1	2/08	0.76*	0.0474*	(1)
A1	1/09	<0.010†	<0.00474†	(4)
B1	2/09	<0.01†	<0.0053†	(3)
C1	3/09	<0.01†	<0.0053†	(3)
D1	4/09	<0.01*	<0.000019*	(3)
E1	5/09	<0.02†	<0.011†	(3)
F1	6/09	<0.02†	<0.011†	(3)
G1	7/09	0.030†	0.0208†	(1)
H1	8/09	0.151	0.0013	(3)

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Total chlorobenzenes.
(n) = Number of data points available.

Table XV-3. Effluent Levels Achieved

VOLATILE AROMATICS (Continued)

DICHLOROBENZENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02	<0.01*	NA	(4)
B1	2/02	<0.01*	NA	(4)
C1	3/02	0.02*	0.019*	(20)
D1	4/02	0.02*	0.019*	(20)
A1	1/09	<0.0167	<0.000032	(3)

NA = Not available.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

VOLATILE AROMATICS (Continued)

HEXACHLOROBENZENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	0.007	NA	(5)
A1	1/09	<0.001	0.0000019	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
(n) = Number of data points available.

Table XV-3. Effluent Levels Achieved

VOLATILE AROMATICS (Continued)

1,2,4-TRICHLOROBENZENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	ND†	NA	(3)
A1	1/09	<0.00133	<0.0000025	(3)
B1	2/09	9.0	1.45	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-4. Effluent Levels Achieved

HALOMETHANES

METHYL CHLORIDE (CHLOROMETHANE)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	ND†°	NA	(1)
B1	2/01	<1.0†	<0.0296†	(2)
A1	1/02	ND†°	NA	(1)
A1	1/08	ND	NA	(1)
A1	1/09	ND†	NA	(3)

NA = Not available.
ND = Not detected.
† = Data from comingled pesticide/other product streams.
° = Analysis not conducted per protocol.
(n) = Number of data points available.

HALOMETHANES (Continued)

METHYLENE CHLORIDE (DICHLOROMETHANE)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	<0.10°	<0.000066°	(3)
A1	1/02	<0.010	<0.00848	(1)
B1	2/02	<0.10†	<0.00204†	(3)
C1	3/02	0.020*	0.00077*	(2)
D1	4/02-D	0.24	0.979	(1)
E1	5/02	<1.1†	<0.860†	(3)
F1	6/02-P	1.49*	0.147*	(3)
G1	7/02-P	<1.42*	<0.260*	(56)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Analysis not conducted per protocol.
(n) = Number of data points available.

Table XV-4. Effluent Levels Achieved

HALOMETHANES (Continued)

CARBON TETRACHLORIDE (TETRACHLOROMETHANE)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02	ND*	NA	(2)
B1	2/02	Trace	NA	(3)
C1	3/02-P	<0.0010*	<0.000018*	(3)
D1	4/02	<0.010	<0.0229	(1)
E1	5/02	<0.010	<0.0229	(1)
F1	6/02-P	<0.140*	<0.0256*	(56)
G1	7/04	ND*	NA	(2)
A1	1/09	5.49	0.048	(3)
B1	2/09	44.5*	2.10*	(3)
C1	3/09	44.5*	2.10*	(3)
A1	1/10	<0.1*	<0.0039*	(270)
B1	2/10	<0.1*	<0.0039*	(270)
C1	3/10	<0.1*	<0.0039*	(270)
D1	4/10	0.216*	0.0166*	(540)
E1	5/10	0.216*	0.0166*	(540)
F1	6/10	0.216*	0.0166*	(540)
G1	7/10	2.32*	0.50*	(3)

NA = Not available.
ND = Not detected.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

HALOMETHANES (Continued)

DICHLOROBROMOMETHANE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09	0.067	0.00046	(3)

(n) = Number of data points available.

Table XV-4. Effluent Levels Achieved

HALOMETHANES (Continued)

CHLOROFORM (TRICHLOROMETHANE)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	<0.30°	<0.000197°	(3)
A1	1/02-D	ND†	NA	(3)
B1	2/02	<0.010†	<0.000179†	(3)
C1	3/02	<0.01†	<0.00128†	(3)
D1	4/02	0.011	0.0252	(1)
E1	5/02	0.011	0.0252	(1)
F1	6/02	0.019†	0.00123†	(1)
G1	7/02	0.023*	0.000406*	(3)
H1	8/02-P	0.06†	0.0566†	(1)
I1	9/02-D	0.06†	0.0566†	(1)
J1	10/02-D	0.06†	0.0566†	(1)
K1	11/02-D	<0.0684*	<0.0125*	(55)
L1	12/02-P	<5.0*	<0.0259*	(10)
M1	13/02-C	28.6†	1.85†	(2)
A1	1/04	0.019†	0.00123†	(1)
B1	2/04	28.6†	1.85†	(2)
A1	1/05-C	<5.0*	<0.0259*	(10)
A1	1/08	<0.010	<0.000505	(1)
A1	1/09	0.21	0.02	(3)
B1	2/09	0.339*	0.016*	(2)
C1	3/09	0.339*	0.016*	(2)
D1	4/09	2.51	0.019	(3)

C = Contract hauling of wastewater after recommended treatment.
D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Analysis not conducted per protocol.
(n) = Number of data points available.

Table XV-4. Effluent Levels Achieved

HALOMETHANES (Continued)

BROMOFORM (TRIBROMOMETHANE)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
No data available				

(n) = Number of data points available.

HALOMETHANES (Continued)

CHLORODIBROMOMETHANE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09	<0.005	<0.000056	(3)

(n) = Number of data points available.

Table XV-5. Effluent Levels Achieved

CYANIDE

CYANIDE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/10-D	<0.0125	<0.000222	(25)
B1	2/10-D°	0.0192*	0.000639*	(540)
C1	3/10-D°	0.0192*	0.000639*	(540)
D1	4/10-D°	0.0192*	0.000639*	(540)
E1	5/10	<0.02*	<0.00079*	(270)
F1	6/10	<0.02*	<0.00079*	(270)
G1	7/10	<0.02*	<0.00079*	(270)
H1	8/10	0.065†	0.0252†	(1)
I1	9/10	0.065†	0.0252†	(1)
J1	10/10-D	<0.0710	<0.00184	(3)
K1	11/10	0.337†	0.0103†	(3)
L1	12/10	0.682†	0.0228†	(700)

D = Direct discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Recommended treatment for pesticide intermediate waste streams only.
(n) = Number of data points available.

Table XV-6. Effluent Levels Achieved

HALOGENATED ETHERS				
BIS(2-CHLOROETHYL) ETHER				
Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/04	0.0527	0.113	(3)

(n) = Number of data points available.

Table XV-7. Effluent Levels Achieved

PHENOLS

PHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01-D	0.120**	0.10**	(3)
A1	1/02	0.002**†	0.0019**†	(24)
B1	2/02	<0.010†	<0.00645†	(4)
C1	3/02	<0.010†	<0.00645†	(4)
D1	4/02	<0.010†	<0.00645†	(4)
E1	5/02	<0.010†	<0.00645†	(4)
F1	6/02	0.042†	0.0747†	(1)
G1	7/02-P	<0.081*	<0.00180*	(3)
H1	8/02-P	0.231*	0.00563*	(68)
I1	9/02	<3.84†	<0.09†	(1,169)
A1	1/09-D	<0.010†	<0.00645†	(4)
B1	2/09	0.029	0.00014	(3)
C1	3/09-P	<0.081*	<0.00180*	(3)
D1	4/09-P	0.231*	0.00563*	(68)
E1	5/09-P	0.562	0.0101	(4)
F1	6/09	2.03†	<0.0140†	(33)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
** = Total phenol.
(n) = Number of data points available.

Table XV-7. Effluent Levels Achieved

PHENOLS (Continued)

2,4-DICHLOROPHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02	<0.0010†	<0.0014†	(2)
B1	2/02-D	<0.0010†	<0.0014†	(2)
C1	3/02	0.018†	0.0116†	(4)
D1	4/02	0.018†	0.0116†	(4)
E1	5/02	0.018†	0.0116†	(4)
F1	6/02	0.018†	0.0116†	(4)
G1	7/02-P	<0.022*	<0.00048*	(3)
H1	8/02-P	<0.0692*	<0.00173*	(67)
I1	9/02-P	0.482°	0.00627°	(46)
J1	10/02-P	0.498°	0.00745°	(661)
K1	11/02-P	<4.32	<0.0752	(298)
L1	12/02-P	<4.32	<0.0752	(298)
M1	13/02	74.3	0.275	(6)
A1	1/09-D	0.018†	0.0116†	(4)
B1	2/09-P	<0.022*	<0.00048*	(3)
C1	3/09-P	<0.0692*	<0.00173*	(67)
D1	4/09-P	<0.0978	<0.00176	(4)
E1	5/09-P	<0.129	<0.00232	(4)
F1	6/09-P	0.482°	0.00627°	(46)
G1	7/09-P	0.498°	0.00745°	(661)
H1	8/09-P	0.523	0.0201	(3)
I1	9/09	0.82	0.0041	(3)
J1	10/09-P	<4.32	<0.0752	(298)
K1	11/09	36.0†	5.80†	(3)
L1	12/09	42.3°*	3.53°*	(1)
M1	13/09	42.3°*	3.53°*	(1)
N1	14/09	42.3°*	3.53°*	(1)
O1	15/09	<110°*	<7.0°*	(337)
P1	16/09	<110°*	<7.0°*	(337)
Q1	17/09	<110°*	<7.0°*	(337)
R1	18/09	200°*	16.7°*	(312)
S1	19/09	200°*	16.7°*	(312)
T1	20/09	200°*	16.7°*	(312)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
° = Reported as total phenol with 2,4-dichlorophenol as principal constituent.
(n) = Number of data points available.

Table XV-7. Effluent Levels Achieved

PHENOLS (Continued)

2,4,6-TRICHLOROPHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-P	<0.010*	<0.000223*	(3)
B1	2/02-P	<0.0154*	<0.000375*	(68)
C1	3/02	0.021†	0.0373†	(2)
D1	4/02	0.180†	0.116†	(4)
E1	5/02	0.180†	0.116†	(4)
F1	6/02	0.180†	0.116†	(4)
G1	7/02	0.180†	0.116†	(4)
A1	1/09-P	<0.010*	<0.000223*	(3)
B1	2/09-P	<0.0154	<0.000375	(68)
C1	3/09-P	<0.0323	<0.000581	(4)
D1	4/09-P	<0.0978	<0.00176	(4)
E1	5/09-P	<0.163	<0.00626	(3)
F1	6/09-D	0.180†	0.116†	(4)

D = Direct discharge of wastewater after recommended treatment.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

PHENOLS (Continued)

PENTACHLOROPHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	1.58	1.75	(6)
A1	1/02	0.230†	0.174†	(3)
B1	2/02	0.230†	0.174†	(3)
C1	3/02	0.35†	0.00921†	(8)

† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-7. Effluent Levels Achieved

PHENOLS (Continued)

4-NITROPHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/08	<1.0	<0.066	(610)
B1	2/08	<1.0	<0.066	(610)
C1	3/08	<7.84	<0.298	(154)
D1	4/08	10.7	0.408	(210)

(n) = Number of data points available.

PHENOLS (Continued)

2,4-DINITROPHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	0.397†	0.489†	(4)

† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-7. Effluent Levels Achieved

PHENOLS (Continued)

2-CHLOROPHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	<0.01*	NA	(4)
B1	2/02-D	<0.01*	NA	(4)
C1	3/02-P	<0.0212*	<0.000516*	(68)
D1	4/02-P	<2.70	<0.076	(3)
A1	1/08-D	<0.01	<0.0000328	(3)
A1	1/09-P	<0.010*	<0.000223*	(3)
B1	2/09-P	<0.01	<0.00013	(3)
C1	3/09-P	<0.0212*	<0.000516*	(68)
D1	4/09-P	0.0340	0.000611	(4)
E1	5/09-P	0.396*	0.0049*	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

PHENOLS (Continued)

2,4-DIMETHYLPHENOL

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/10	ND	NA	(3)

NA = Not available.
ND = Not detected.
(n) = Number of data points available.

Table XV-8. Effluent Levels Achieved

POLYNUCLEAR AROMATICS

NAPHTHALENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02	<0.010†	<0.0814†	(4)
B1	2/02	<0.010†	<0.0814†	(4)
A1	1/09	0.297*	0.014*	(3)

* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-9. Effluent Levels Achieved

METALS

COPPER

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	0.18†	0.0153†	(1)
A1	1/02-D	0.06†	0.0589†	(6)
A1	1/05-C	2.2*	0.0114*	(325)
B1	2/05-C	2.8*	0.011*	(57)
A1	1/09	0.114†	0.00202†	(3)

C = Contract hauling of wastewater after recommended treatment.
D = Direct discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

METALS (Continued)

ZINC

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/05-P	0.18*	0.011*	(2)
B1	2/05-P	0.18*	0.011*	(2)
C1	3/05	1.77	0.142	(74)
D1	4/05	<3.50	<0.489	(23)

P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

Table XV-10. Effluent Levels Achieved

CHLORINATED ETHANES AND ETHYLENES

1,2-DICHLOROETHANE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	ND†°	NA	(1)
B1	2/02-D	0.18	0.118	(1)
A1	1/08	<0.012	<0.000038	(3)
A1	1/09-D	0.18	0.118	(1)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
† = Data from comingled pesticide/other product streams.
° = Analysis not conducted per protocol.
(n) = Number of data points available.

CHLORINATED ETHANES AND ETHYLENES

VINYL CHLORIDE (CHLOROETHYLENE)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)

No data available

(n) = Number of data points available.

Table XV-10. Effluent Levels Achieved

CHLORINATED ETHANES AND ETHYLENES (Continued)

TETRACHLOROETHYLENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02	0.051†	1.52†	(3)
B1	2/02-D	6.90*	3.89*	(1)
C1	3/02	<98.0	<0.92	(6)
A1	1/09	0.018	0.00017	(3)
B1	2/09	0.810*	0.038*	(3)
C1	3/09	0.810*	0.038*	(3)
D1	4/09-D	1.45*	0.818*	(1)
A1	1/10	1.45*	0.818*	(1)

D = Direct discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

CHLORINATED ETHANES AND ETHYLENES (Continued)

1,1,1-TRICHLOROETHANE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	ND†	NA	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-10. Effluent Levels Achieved

CHLORINATED ETHANES AND ETHYLENES (Continued)

1,2-DICHLOROETHYLENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	0.54*	NA	(1)
A1	1/09-D	0.54*	NA	(1)
B1	2/09-D	0.54*	NA	(1)
A1	1/10	0.54*	NA	(1)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

CHLORINATED ETHANES AND ETHYLENES (Continued)

TRICHLOROETHYLENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	ND†	NA	(3)
B1	2/09	<0.01	<0.000084	(3)
C1	3/02-P	<0.04	<0.0011	(3)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
P = POTW discharge of wastewater after recommended treatment.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-11. Effluent Levels Achieved

NITROSAMINES

N-NITROSODI-N-PROPYLAMINE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/08-D	<0.00034*	<0.00024*	(229)
B1	2/08-D	0.000384*°	0.000265*°	(57)
C1	3/08-D	<0.0015††	<0.000282††	(2)
D1	4/08-D	0.0041**	0.000013**	(3)
E1	5/08-D	0.0067**	0.000038**	(85)
F1	6/08-D	0.0276**	0.0000723**	(420)

D = Direct discharge of wastewater after recommended treatment.
* = Data from final effluent which is comingled pesticide/other product streams.
** = After pretreatment.
†† = Effluent from tertiary treatment which is comingled pesticide/other product streams.
° = Total nitrosamines.
(n) = Number of data points available.

NITROSAMINES (Continued)

N-NITROSODIMETHYLAMINE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/08-D	0.000330**	0.000000865**	(330)

D = Direct discharge of wastewater after recommended treatment.
** = After pretreatment.
(n) = Number of data points available.

Table XV-12. Effluent Levels Achieved

PHTHALATES

DIMETHYL PHTHALATE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
No data available				

(n) = Number of data points available.

PHTHALATES (Continued)

DIETHYL PHTHALATE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01-D	0.36	NA	(1)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
(n) = Number of data points available.

PTHALATES (Continued)

BIS(2-ETHYLHEXYL) PHTHALATE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/02-D	ND	NA	(1)

D = Direct discharge of wastewater after recommended treatment.
NA = Not available.
ND = Not detected.
(n) = Number of data points available.

Table XV-13. Effluent Levels Achieved

DICHLOROPROPANE-DICHLOROPROPENE

1,2-DICHLOROPROPANE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
No data available				

(n) = Number of data points available.

DICHLOROPROPANE-DICHLOROPROPENE (Continued)

1,3-DICHLOROPROPENE (1,2-DICHLOROPROPYLENE)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
No data available				

(n) = Number of data points available.

Table XV-14. Effluent Levels Achieved

PRIORITY POLLUTANT PESTICIDES

CHLORDANE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
No data available				

(n) = Number of data points available.

PRIORITY POLLUTANT PESTICIDES (Continued)

4,4'-DDT

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09-P	<0.195	<0.000189	(32)
B1	2/09	112	0.127	(1)

P = POTW discharge of wastewater after recommended treatment.
(n) = Number of data points available.

Table XV-14. Effluent Levels Achieved

PRIORITY POLLUTANT PESTICIDES (Continued)

ENDRIN

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09-P	<0.015	<0.0016	(171)
B1	2/09-P	0.539	0.0586	(3)

P = POTW discharge of wastewater after recommended treatment.
(n) = Number of data points available.

PRIORITY POLLUTANT PESTICIDES (Continued)

HEPTACHLOR

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09-P	0.010	0.00082	(174)
B1	2/09-P	0.038	0.00315	(3)

P = POTW discharge of wastewater after recommended treatment.
(n) = Number of data points available.

Table XV-14. Effluent Levels Achieved

PRIORITY POLLUTANT PESTICIDES (Continued)

TOXAPHENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09-D	0.00067	0.0000060	(3)
B1	2/09-D	0.00123	0.00000974	(84)
C1	3/09-D	0.005	0.001	(4)
D1	4/09-D	0.01	0.002	(40)

D = Direct discharge of wastewater after recommended treatment.
(n) = Number of data points available.

Table XV-15. Effluent Levels Achieved

DIENES

HEXACHLOROCYCLOPENTADIENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09-P	0.034*	0.0017*	(104)
B1	2/09-P	0.034*	0.0017*	(104)
C1	3/09-P	0.123*	0.0060*	(3)
D1	4/09-P	0.123*	0.0060*	(3)

P = POTW discharge of wastewater after recommended treatmen .
* = Data from comingled pesticide streams.
(n) = Number of data points available.

DIENES (Continued)

HEXACHLOROBUTADIENE

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09-P	0.01*	0.0016*	(3)
B1	2/09-P	0.01*	0.0016*	(3)

P = POTW discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

Table XV-16. Effluent Levels Achieved

	TCDD			
	TCDD			
Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/09	<0.000002*	<0.0000000167*	(3)
B1	2/09	<0.000002*	<0.0000000167*	(3)
C1	3/09	<0.000002*	<0.0000000167*	(3)
D1	4/09	0.022*	0.00018*	(1)
E1	5/09	0.022*	0.00018*	(1)
F1	6/09	0.022*	0.00018*	(1)

TCDD = 2,3,7,8-Tetrachlorodibenzo-p-dioxin.
* = Data from comingled pesticide streams.
(n) = Number of data points available.

Table XV-17. Effluent Levels Achieved

AMMONIA

AMMONIA

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	77.9*	<6.75*	(42)
B1	2/01	<125*	<17.5*	(15)
A1	1/02	77.9*	<6.75*	(42)
B1	2/02	77.9*	<6.75*	(42)
C1	3/02	77.9*	<6.75*	(42)
D1	4/02-D	95.0	0.91	(1)
E1	5/02-D	103	0.793	(3)
F1	6/02	163	2.25†	(631)
G1	7/02	163	2.25†	(631)
A1	1/04	163	2.25†	(631)
A1	1/05	<125	<17.5*	(15)
A1	1/10	<4.0*	<0.157*	(270)
B1	2/10	<4.0*	<0.157*	(270)
C1	3/10	<4.0*	<0.157*	(270)
D1	4/10	4.44*	0.34*	(540)
E1	5/10	4.44*	0.34*	(540)
F1	6/10	4.44*	0.34*	(540)
G1	7/10	163†	2.25†	(631)
H1	8/10	163†	2.25†	(631)
I1	9/10	163†	2.25†	(631)
J1	10/10	163†	2.25†	(631)
K1	11/10	163†	2.25†	(631)
L1	12/10	163†	2.25†	(631)
M1	13/10	163†	2.25†	(631)

D = Direct discharge of wastewater after recommended treatment.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-18. Effluent Levels Achieved

ASBESTOS

ASBESTOS

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
A1	1/01	ND†	NA	(1)
B1	2/01	ND†	NA	(1)
C1	3/01	ND†	NA	(1)
D1	4/01	ND†	NA	(1)
E1	5/01	ND†	NA	(1)
F1	6/01	ND†	NA	(1)
G1	7/01	ND†	NA	(1)
H1	8/01	ND†	NA	(1)
I1	9/01	0.000001†	NA	(1)
J1	10/01	0.000001†	NA	(1)
K1	11/01	0.000001†	NA	(1)
L1	12/01	0.000003†	NA	(1)
M1	13/01	0.000003†	NA	(1)
N1	14/01	0.000078†	NA	(1)
O1	15/01	0.000171†	NA	(1)
P1	16/01	0.000171†	NA	(1)
A1	1/02	ND†	NA	(1)
B1	2/02	ND†	NA	(1)
C1	3/02	ND†	NA	(1)
D1	4/02	ND*	NA	(1)
E1	5/02	ND†	NA	(1)
F1	6/02	ND†	NA	(1)
G1	7/02	ND†	NA	(1)
H1	8/02	ND†	NA	(1)
I1	9/02	ND†	NA	(1)
J1	10/02	0.000001†	NA	(1)
K1	11/02	0.000001†	NA	(1)
L1	12/02	0.000001†	NA	(1)
M1	13/02	0.000001†	NA	(1)
N1	14/02	0.000001†	NA	(1)
O1	15/02	0.000001†	NA	(1)
P1	16/02	0.000001†	NA	(1)
Q1	17/02	0.000001†	NA	(1)
R1	18/02	0.000001†	NA	(1)
S1	19/02	0.000001†	NA	(1)

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-18. Effluent Levels Achieved

ASBESTOS (Continued)

ASBESTOS (Continued)

Pesticide	Plant/ Subcategory	mg/l	lbs/1000 lbs	(n)
T1	20/02	0.000001†	NA	(1)
U1	21/02	0.000001†	NA	(1)
V1	22/02	0.000001†	NA	(1)
W1	23/02	0.000001†	NA	(1)
X1	24/02	0.000001†	NA	(1)
Y1	25/02	0.000001†	NA	(1)
Z1	26/02	0.000003†	NA	(1)
A2	27/02	0.000025*	NA	(1)
B2	28/02	0.000025*	NA	(1)
C2	29/02	0.000078†	NA	(1)
D2	30/02	0.000171†	NA	(1)
E2	31/02	0.0006†	NA	(1)
F2	32/02	0.0006†	NA	(1)
G2	33/02	0.0006†	NA	(1)
H2	34/02	0.0006†	NA	(1)
I2	35/02	0.0006†	NA	(1)
J2	36/02	0.0006†	NA	(1)
A1	1/03	0.000003†	NA	(1)
B1	2/03	0.00001†	NA	(1)
A1	1/04	ND†	NA	(1)
A1	1/05	0.000003†	NA	(1)

NA = Not available.
ND = Not detected.
* = Data from comingled pesticide streams.
† = Data from comingled pesticide/other product streams.
(n) = Number of data points available.

Table XV-19. Selected Long-Term Averages for Priority Pollutants

Priority Pollutants by Groups	Long-Term Average (lb/1,000 lbs) Indirect Discharge	Direct Discharge
Volatile Aromatics		
Benzene	< 0.037	< 0.00037
Chlorobenzene	< 0.037	< 0.00037
Toluene	< 0.037	< 0.00037
1,2-Dichlorobenzene*	0.0938	0.0525
1,4-Dichlorobenzene*	0.0938	0.0525
1,2,4-Trichlorobenzene*	0.0938	0.0525
Halomethanes		
Carbon tetrachloride	< 0.037	< 0.00037
Chloroform	< 0.037	< 0.00037
Methyl bromide	< 0.037	< 0.00037
Methyl chloride	< 0.037	< 0.00037
Methylene chloride	< 0.037	< 0.00037
Cyanide		
Cyanide	0.0015	0.00075
Haloethers		
Bis(2-chloroethyl) ether†	Zero	Zero
Phenols		
2,4-Dichlorophenol	0.037	0.0037
2,4-Dinitrophenol	0.037	0.0037
4-Nitrophenol	0.037	0.0037
Pentachlorophenol	0.037	0.0037
Phenol	0.037	0.0037
Metals		
Copper	0.019	0.0094
Zinc	0.019	0.0094
Chlorinated Ethanes and Ethylenes		
1,2-Dichloroethane	0.037	0.0037
Tetrachloroethylene	0.037	0.0037
Nitrosamines		
N-nitrosodi-n-propylamine	0.000037	0.000037

Table XV-19. Selected Long-Term Averages for Priority Pollutants (Continued, Page 2 of 2)

Priority Pollutants by Groups	Long-Term Average (lb/1,000 lbs) Indirect Discharge	Direct Discharge
Dichloropropane and Dichloropropene		
1,3-Dichloropropene†	Zero	Zero
Dienes		
Hexachlorocyclopentadiene	0.0017	0.00086
Pesticides		
BHC-Alpha**	0.00129	0.00129
BHC-Beta**	0.00129	0.00129
BHC-Delta**	0.00129	0.00129
Endosulfan-Alpha**	0.00129	0.00129
Endosulfan-Beta**	0.00129	0.00129
Endrin**	0.00129	0.00129
Heptachlor**	0.00129	0.00129
Lindane (BHC-Gamma)**	0.00129	0.00129
Toxaphene**	0.00129	0.00129

* Proposed for regulation only in those processes in which it is the manufactured product; proposed for exclusion from regulation in all other processes where it is expected to be controlled by regulation of chlorobenzene.

† Proposed for regulation only in those processes in which it is the manufactured product; proposed to be excluded from regulation in all other processes due to lack of adequate monitoring data.

** Regulation applies to only direct discharge from new sources (NSPS).

Table XV-20. Selected Nonconventional Pesticide Long-Term Averages by Subcategory

Subcategory	Long-Term Average (lb/1,000 lbs) Indirect Discharge	Direct Discharge
1	0.0302	0.0261
2	0.0938	0.0525
3	0.0145	0.00473
4	0.00243	0.00129
5	0.0182	0.00167
6	*	*
7	*	*
8	0.00129	0.00129†
9	0.00129	0.00129†
10	0.0583	0.0493
11	Zero	Zero
12	Zero	Zero†
13	Zero	Zero†

* No pesticides are proposed for regulation in this subcategory.

† Regulation applies to only direct discharge from new sources (NSPS).

Table XV-21. Selected Long-Term Averages for Direct Discharge of BOD, TSS, pH, and COD

Pollutant Parameter	Long-Term Average (lb/1,000 lbs)
BOD	1.12
TSS	1.31
pH	*
COD	8.01

* The pH shall be between the values of 6.0 to 9.0.

Table XV-22. Effluent Variability Factors

Plant Code	Parameter	Data Type	No. of Data Points	Monthly Variability Factor (30-day/mo)	Daily Variability Factor
1	Volatile Aromatics	Monthly	21	2.75	N/A
2	Phenol	Daily	334	1.26	2.92
3	Copper	Daily	56	1.25	3.86
4	Atrazine	Daily	154	1.54	7.64
5	Dinoseb	Daily	221	1.75	9.89
6	Chlorobenzilate	Daily	109	1.33	5.95
7	Cyanide	Daily	700	1.33	3.25
8	Hexachloro-cyclopentadiene	Daily	68	1.42	3.78
9	Nitrophenol	Monthly	12	2.66	N/A
10	Metribuzin	Daily	79	2.02	11.36
11	Toluene	Monthly	24	2.35	N/A
12	Carbon Tetrachloride	Monthly	24	3.00	N/A
13	Cyanide	Monthly	24	1.85	N/A
14	n-Nitrosodi-n-propylamine	Daily	60	1.31	4.56
15	Alachlor	Daily	364	1.38	4.09
16	Phenol	Daily	61	1.38	7.24
17	Toluene	Daily	317	1.56	7.51

SECTION XVI

ENVIRONMENTAL ASSESSMENT

An assessment of the environmental effects of implementing the proposed standards and limitations is presented in a separate document prepared by EPA/Monitoring and Data Support Division. This assessment projects the significance of post-regulatory discharges of nonconventional pesticides and priority pollutants on human health, aquatic life, and the operation of POTWs.

The basis for determining the environmental significance of direct discharger priority pollutants to both freshwater and estuarine systems is a comparison of proposed limitations with water quality criteria (WQC) (U.S. EPA, 1980f) or pollutant-specific toxicity data. Plant-specific priority pollutant limitations (expressed as concentrations) were supplied by the technical contractor.

The environmental significance of indirect discharge priority pollutants to both freshwater and estuarine systems is determined through the use of a predictive POTW computer model. Contractor-provided data, in the form of proposed standards (expressed as plant-specific concentrations), average daily plant production, total plant discharge flow, and size of the receiving POTW were also used in the model.

Plant-specific effluent limitations and pretreatment standards (expressed as concentrations) for 150 nonconventional pesticides were compared to available pesticide LC_{50}/EC_{50} values in order to determine the potential environmental significance. This information was gathered by the technical contractor for use by the Agency. Available LC_{50}/EC_{50} values are presented in Section IX of this report.

Information gathered for additional consideration included pesticide use, carcinogenicity, oral LD_{50} in rats, and solubility in water (see Section IX).

Whenever possible, the procedure used by the technical contractor in selecting appropriate data for this assessment was consistent with the EPA protocol used in screening data to determine the 1980 WQC (see U.S. EPA, 1980f). For example, data were rejected for formulated mixtures and emulsifiable concentrates but were included for technical grade products.

SECTION XVII

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SECTION XVIII

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SECTION XIX

GLOSSARY

Abscission--Process by which a leaf or other part is separated from the plant.

Acaricide (miticide)--An agent that destroys mites and ticks.

Act--The Federal Water Pollution Control Act Amendments of 1972, Public Law 92-500, as amended by the Clean Water Act of 1977, Public Law 95-217.

Activated Carbon--Carbon which is treated by high-temperature heating with steam or carbon dioxide producing an internal porous particle structure.

Activated Sludge--Sludge floc produced in raw or settled wastewater by the growth of zoogleal bacteria and other organisms in the presence of dissolved oxygen and accumulated in sufficient concentration by returning floc previously formed.

Activated Sludge Process--A biological wastewater treatment process in which a mixture of wastewater and activated sludge is agitated and aerated. The activated sludge is subsequently separated from the treated wastewater (mixed liquor) by sedimentation and wasted or returned to the process as needed.

Active Ingredient--The ingredient of a pesticide which is intended to prevent, destroy, repel, or mitigate any pest. The active ingredients may make up only a small percentage of the final product which also consists of binders, fillers, diluents, etc.

Activity Coefficient--An auxiliary thermodynamic function to express the volatile properties of binary systems that exhibit nonideal vapor equilibrium behavior. It may also be regarded as a correction factor that may be applied to ideal conditions to obtain "real" system properties under proper temperature and pressure conditions.

Aerated Lagoon--A natural or artificial wastewater treatment pond in which mechanical or diffused-air aeration is used to supplement the oxygen supply.

Aerobic--Condition in which free molecular oxygen is present.

Aldrin-Toxaphene Pesticide Structural Group--Chlordane, Dienochlor, Endosulfan, Endrin, Heptachlor, Mirex, Toxaphene.

Algicide--Chemical used to control algae and aquatic weeds.

Amide Pesticide Structural Group--Alachlor, Butachlor, Deet, Diphenamid, Fluoroacetamide, Napropamide, Naptalam, Pronamide, Propachlor.

Amide Type Pesticide Structural Group--Aldicarb, Methomyl, Oxamyl, Thiofanox.

Anaerobic--Condition in which free molecular oxygen is absent.

Avicide--Lethal agent used to destroy birds but also refers to materials used for repelling birds.

Attractant, insect--A substance that lures insects to trap or poison-bait stations. Usually classed as food, oviposition, and sex attractants.

Bactericide--Any bacteria-killing chemical.

BAT Effluent Limitations--Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Available Technology Economically Achievable. These limitations must be achieved by July 1, 1984.

BCT--Best Conventional Pollutant Control Technology.

Benzidines (Priority Pollutant)--Benzidine, 3,3'-Dichlorobenzidine.

Bioconcentration Factor (B.C.F.)--The ratio of the concentration of a chemical in aquatic organisms (ug chemical/g organism) to the amount in water at equilibrium (ug chemical/g water).

Biological Oxidation--Breaking down (oxidizing) organic carbon by bacteria that utilize free dissolved oxygen (aerobic) or "chemically bound" oxygen (anaerobic).

Biological Wastewater Treatment--Forms of wastewater treatment in which bacterial or biochemical action is intensified to stabilize, oxidize, and nitrify the unstable organic matter present. Intermittent sand filters, contact beds, trickling filters, and activated sludge processes are examples.

Blowdown--The removal of a portion of any process flow to maintain the constituents of the flow at desired levels.

BOD--Biochemical oxygen demand is a measure of biological decomposition of organic matter in a water sample. It is determined by measuring the oxygen required by microorganisms to oxidize the organic contaminants of a water sample under standard laboratory conditions. The standard conditions include incubation for five days at 20°C.

BOD5--Biochemical oxygen demand, measured after five-day.

Botanical Pesticide--A pesticide produced from naturally occurring chemicals found in some plants. Examples are nicotine, pyrethrum, strychnine, and rotenone.

Botanical Pesticide Structural Group--Allethrin, Permethrin, Pyrethrin, Resmethrin, Rotenone.

BPT Effluent Limitations--Limitations for point sources, other than publicly owned treatment works, which are based on the application of the Best Practicable Control Technology Currently Available. These limitations must be achieved by July 1, 1977.

Btu--British thermal unit.

Bypass--An act of intentional noncompliance during which waste treatment facilities are circumvented in emergency situations.

°C--Degrees Centigrade.

Carbamate Pesticide Structural Group--Aminocarb, Barban, Bendiocarb, Benomyl, Carbaryl, Carbendazim, Carbofuran, Chlorpropham, Methiocarb, Mexacarbate, Polyphase antimildew, Propham, Propoxur, Sulfallate, SWEP.

cc--Cubic centimeter.

Cal--Calorie.

Carbamates--A group of insecticides which act on the nervous system by inhibiting the acetylcholinesterase enzyme at the nerve synapse.

Carcinogen--A substance that causes cancer in animal tissue.

Chemical Name--Scientific name of the active ingredient(s) found in the formulated product. The name is derived from the chemical structure of the active ingredient.

Chemical Oxidation--Oxidizing organic carbon by chemical means.

Chemosterilant--Chemical compounds that cause sterilization or prevent effective reproduction.

Chlorinated Ethanes and Ethylenes (Priority Pollutant)--Chloroethane; 1,1-Dichloroethane; 1,2-Dichloroethane; 1,1,1-Trichloroethane; 1,1,2-Trichloroethane; 1,1,2,2-Tetrachloroethane; Hexachloroethane; Vinyl chloride; 1,1-Dichloroethylene; 1,2-Trans-dichloroethylene; Trichloroethylene; Tetrachloroethylene.

Chlorinated Aryloxyalkanoic Acids and Esters Pesticide Structural Group--2,4-D; 2,4-D isobutyl ester; 2,4-D isooctyl ester; 2,4-D salt; 2,4-DB; 2,4-DB isobutyl ester; 2,4-DB isooctyl ester; Dichlorprop; MCPA; MCPA isooctyl ester; MCPP, Silvex; Silvex isooctyl ester; Silvex salt; 2,4,5-T.

Cholinesterase--The enzyme responsible for nervous impulse transmission.

Clarifier--A treatment unit of which the primary purpose is to reduce the amount of suspended matter in a liquid.

Clean Water Act--Enacted in 1977 to amend the Federal Water Pollution Control Act of 1972 and broadens regulations to improve water quality and the control of potentially toxic pollutants.

cm--Centimeter.

COD--Chemical oxygen demand. Its determination provides a measure of the oxygen demand equivalent to that portion of matter in a sample which is susceptible to oxidation by a strong chemical oxidant.

Combined Wastewater--Wastewater from a number of pesticide, pesticide intermediate, and non-pesticide processes.

Common Pesticide Name--A common chemical name given to a pesticide by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names but have only one recognized common name. For example, the common name for Sevin insecticide is carbaryl.

Contract Hauling--Disposal of waste products through an outside party for a fee.

Conventional Pollutants--For the Pesticide Industry conventional pollutants are defined as BOD, TSS, and pH.

cu ft--Cubic feet.

Cyanate Pesticide Structural Group--Methylene bisthiocyanate; Nabonate; TCMTB.

Cyanides (Priority Pollutant)--Cyanide.

Cyclodienes--A group of insecticides which are structurally characterized as chlorinated cyclic hydrocarbons.

DDT Type Pesticide Structural Group--Chlorobenzilate; DDD; DDE; DDT; Dicofol; Methoxychlor; Perthane.

Deep Well Injection--Disposal of wastewater into a deep-well such that a porous, permeable formation of a large area and thickness is available at sufficient depth to ensure continued, permanent storage.

Defoliant--A chemical that initiates abscission.

Desiccant--A chemical that induces rapid dehydration of a leaf or plant part.

Design Effluent Level--Long-term average effluent levels demonstrated or judged achievable for recommended treatment technologies presented in Section VI, from maximum raw waste load levels presented in Section V.

Dichloropropane and Dichloropropene (Priority Pollutant)--1,2-Dichloropropane; 1,2-Dichloropropylene.

Dienes (Priority Pollutant)--Hexachlorobutadiene; Hexachlorocyclopentadiene.

Dioxin Type Pesticide Structural Group--Dimethoxane.

Direct Discharge--Discharge of wastewater into navigable waters.

Disinfectant--A substance used for the art of killing the larger portion of microorganisms in or on a substance with the probability that all pathogenic bacteria are killed by the agent used.

Dual Significance--Classification of priority pollutants which are: (1) manufactured pesticide products (primary significance) and are controlled by regulating other pollutants of primary significance (secondary significance), or (2) manufactured pesticide products with zero wastewater discharge (primary significance) and lack adequate monitoring data to propose regulations in other pesticide processes (secondary significance).

e--The base for the natural or Naperian logarithms which equals 2.71828.

EMSL--Environmental Monitoring and Support Laboratory.

Evaporation Pond--An open holding facility which depends primarily on climatic conditions such as evaporation, precipitation, temperature, humidity, and wind velocity to effect dissipation (evaporation) of wastewater. External means such as spray recirculation or heating can be used to increase the rate of evaporation.

Excursion--An excursion, sometimes called an upset, is unintentional noncompliance occurring for reasons beyond the reasonable control of the permittee.

°F--Degrees Fahrenheit.

FIFRA--The Federal Insecticide, Fungicide and Rodenticide Act of 1947.

Flocculation--The agglomeration of colloidal and finely divided suspended matter.

Flotation--The raising of suspended matter to the surface of the liquid in a tank as scum--by aeration, the evolution of gas, chemicals, electrolysis, heat, or bacterial decomposition--and the subsequent removal of the scum by skimming.

F:M ratio--The ratio of organic material (food) to mixed liquid (microorganisms) in an aerated sludge aeration basin.

Formulation/packaging of Pesticides--The physical mixing of technical grade pesticide ingredients into liquids, dusts and powders, or granules, and their subsequent packaging in a marketable container.

fpm--Feet per minute.

fps--Feet per second.

ft--Feet.

Fumigant--A volatile material that forms vapors that destroy insects, pathogens, and other pests.

Fungicide--A chemical that kills fungi.

Gal--Gallons.

Gal/1,000 lbs--Gallons of wastewater flow per 1,000 pounds of pesticide production.

GC--Gas chromatograph.

GC/MS--Gas chromatography/mass spectrometry.

Genome--A haploid set of chromosomes, or of chromosomal genes, inherited as a unit from one parent.

Girdling--Removal of bark and cambium layer around a plant stem in the form of a ring.

Goitrogenic--Tending to produce goiters (an enlargement of the thyroid gland visible as a swelling of the front of the neck).

gpd--Gallons per day.

gpm--Gallons per minute.

Growth Regulator--Organic substance effective in minute amounts for controlling or modifying (plant or insect) growth processes.

Haloethers (Priority Pollutant)--Bis(chloromethyl)ether; Bis(2-chloroethyl)ether; 2-chloroethyl vinyl ether; Bis(2-chloroisopropyl)ether; Bis(2-chloroethoxy)methane; 4-chlorophenyl phenyl ether; 4-Bromophenyl phenyl ether.

Halogenated Aliphatic Pesticide Structural Group--BHC; Chloropicrin; Dalapon; DBCP; D-D; Dichloroethyl ether; Dichloropropene; Ethylene dibromide; Lindane; Methyl bromide.

Halogenated Aromatic Pesticide Structural Group--Bifenox; Bromoxynil; Bromoxynil octanoate; Captafol; Chloramben; Chlorobenzene; Chlorophacinone; Chlorothalonil; Coumachlor; DCPA; Dicamba; Dichlorobenzene, ortho; Dichlorobenzene, para; Dichlorophen; Dichlorophen salt; Hexachlorophene; Nitrofen; PCNB; PCP; PCP salt; Piperalin; Propanil; Trichlorobenzene.

Halomethanes (Priority Pollutant)--Methyl chloride; Methyl bromide; Methylene chloride; Chloroform; Bromoform; Dichlorobromomethane; Chlorodibromomethane; Carbon tetrachloride; Trichlorofluoromethane; Dichlorodifluoromethane.

Hepatocellular Carcinomas--Malignant tumors of the cells comprising the outer layer of the liver.

Hepatoma--Malignant tumor of the liver proper.

Herbicide--Chemical substance used to destroy undesirable plant life such as weeds.

Heterocyclic With Nitrogen in the Ring Pesticide Structural Group--BBTAC; Bentazon; Captan; Cycloheximide; Dowicil 75; Ethoxyquin 66%; Ethoxyquin 86%; Fenarimol; Folpet; Glyodin; Maleic Hydrazide; MGK 264; MGK 326; Molinate; Norflurazon; Paraquat; Picloram; 8 Quinolinol citrate; 8 Quinolinol sulphate; Quinomethionate.

hp--Horsepower.

hr--Hour.

Hydrolysis--The degradation of pesticide active ingredients, most commonly through the application of heat at either acid or alkaline conditions.

in--Inch.

Incineration--The combustion (by burning) of organic matter in vapor and/or aqueous streams.

Inorganic Pesticide--Pesticides that do not contain carbon.

Insect-Growth Regulator (IGR)--Chemical substance that disrupts the action of insect hormones controlling molting, maturity from pupal stage to adult, and others.

Insecticide--Chemical substance used to control insects.

Intraperitoneal--Within the smooth transparent serous membrane that lines the cavity of the abdomen of mammals.

kg--Kilogram.

kkg--1,000 kilograms.

kPa--Kilopascal-SI unit of pressure equal to 0.01 bars or 0.75 millimeters of mercury.

kw--Kilowatt.

L(l)--Liter.

Lagoon--A pond containing raw or partially treated wastewater in which aerobic or anaerobic stabilization occurs.

Land Disposal--Disposal of wastewater onto land.

lb--Pound.

lbs/1,000 lbs--The mass of a particular pollutant (in pounds) per 1,000 pounds of pesticide production.

LC50--Lethal concentration 50; the concentration of a toxic material at which 50 percent of the test organisms die when exposed to the toxic material by a route other than respiration, i.e., orally or dermally, expressed in mg (toxic material)/kg (body weight).

LD50--Lethal dose 50; the dose of a toxic material at which 50 percent of the test organisms die when exposed to the toxic material by a route other than respiration, i.e., orally or dermally, expressed in mg (toxic material)/kg (body weight).

Long-Term Average--The average (mg/l or lbs/1,000 lbs) effluent for a pollutant at a particular point in the wastewater treatment system, based on available data. Treatment variability factors may be multiplied by the long-term average to derive 30-day maximum and daily maximum effluent limitations.

Level of Interest--The detection limit as an analytical goal for this project, as follows: Organic pollutants = 0.01 mg/l; Pesticides = 0.001 mg/l; Metals (mg/l)

Zn = 1.0	Pb = 0.025
Sb = 0.1	Hg = 0.001
As = 0.025	Ni = 0.5
Be = 0.05	Se = 0.01
Cd = 0.005	Ag = 0.005
Cr = 0.025	Tl = 0.05
Cu = 0.02	

m--Meter.

Manufacturer of Pesticide Active Ingredients--The chemical and/or physical conversion of raw materials to technical grade ingredients intended to prevent, destroy, repel, or mitigate any pest. For purposes of this study only the final synthesis step is included.

Manufacturer of Pesticide Intermediates--The manufacture of materials resulting from each reaction step in the creation of pesticide active ingredients, except for the final synthesis step. According to this definition an excess of materials need not be produced.

Manufacturer of Products Other Than Pesticides--The manufacture of products not specifically defined in the scope of coverage (e.g., organic chemicals, plastics and synthetics, pharmaceuticals, etc.).

Mercaptan--Various compounds with the general formula R-SH that are analogous to the alcohols and phenols but contain sulphur in place of oxygen and often have disagreeable odors.

Metallo-Organic Pesticides--A class of organic pesticides containing one or more metal or metalloid atoms in the structure.

Metallo-Organic Pesticide Structural Group--Cyhexatin; Fentin hydroxide; Ferbam; Mancozeb; Maneb; Niacide; Tributyltin benzoate; Tributyltin fluoride; Tributyltin oxide; Vancide 512; Vancide 512 dispersion; ZAC; Zineb; Ziram.

Metals (Priority Pollutant)--Antimony, Arsenic, Beryllium, Cadmium, Chromium, Copper, Lead, Mercury, Nickel, Selenium, Silver, Thallium, Zinc.

Metals Separation--Metallic ion removal from wastewater by conversion to an insoluble form using such agents as lime, soda ash, or caustic followed by a separation process, usually clarification or filtration.

mg--Milligram.

MG--Million gallons.

MGD--Million gallons per day.

mg/l--Milligrams per liter (equal parts per million, ppm, when the specific gravity is one).

Microbial--Of or pertaining to a pathogenic bacterium.

min--Minute.

Miscellaneous Priority Pollutants--Acrolein, Acrylonitrile, Asbestos, Isophorone, 1,2-Diphenylhydrazine.

Miticide--Chemical substance used to destroy mites, acaricides.

ml/l--Milliliters per liter.

MLSS--Mixed-liquor suspended solids.

MLVSS--Mixed-liquor volatile suspended solids.

mm--Millimeter.

Moiety--A chemical functional group.

Molluscicide--A chemical used to kill or control snails and slugs.

Mutagen--Substance causing genes in an organism to mutate or change.

NACA--National Agricultural Chemicals Association.

Navigable Waters--Includes all navigable waters of the United States; tributaries of navigable waters; interstate waters; intrastate lakes; rivers and streams which are utilized by interstate travelers for recreational or other purposes; intrastate lakes, rivers and streams from which fish or shellfish are taken and sold in interstate commerce; and intrastate lakes, rivers and streams which are used for industrial purposes by industries in interstate commerce.

Nematicide--A chemical used to kill nematodes.

Nitro Pesticide Structural Group--Benfluralin, CDN, DCNA, Dinocap, Dinoseb, Ethalfluralin, Fluchloralin, Giv-Gard, Isopropalin, Metasol J-26, Oryzalin, Profluralin, Trifluralin,

Nitrosamines (Priority Pollutant)--N-nitrosodimethylamine, N-nitrosodi-n-propylamine, N-nitrosodiphenylamine.

Nitrosubstituted Aromatics (Priority Pollutant)--Nitrobenzene; 2,4-Dinitrotoluene; 2,6-Dinitrotoluene.

Noncategorized Pesticides Structural Group--Benzyl benzoate, Benzyl bromoacetate, Busan 90, Cycloprate, Fluoridone, HAE, HAMP, Kinoprene, Methoprene, NMI, Oxyfluorfen, Piperonyl butoxide, Sodium monofluoroacetate, Warfarin.

Noncontact Wastewater--Wastewater which is not contaminated by the process or related materials. Examples include boiler blowdown, cooling water, sanitary sewage. Storm water from outside the immediate manufacturing area may be included in this definition if it is not contaminated from product spills, etc.

Nonconventional Pollutants--For the Pesticide Industry nonconventional pollutants are defined as nonpriority pollutant pesticides, COD, ammonia, and manganese (see Table X-1).

Nonhalogenated Aliphatic Pesticide Structural Group--Propionic acid.

Nonhalogenated Aromatic Pesticide Structural Group--Biphenyl, Coumafuryl, Coumatetralyl, Diphacinone, Phenylphenol, Phenylphenol sodium salt, Pindone.

Nonhalogenated Cyclic Aliphatic Pesticide Structural Group--Endothall.

NPDES--National Pollution Discharge Elimination System. A federal program requiring industry to obtain permits to discharge plant effluents to the nation's water courses.

NSPS--New Source Performance Standards.

Nutrients--The nutrients in contaminated water are routinely analyzed to characterize the food available for microorganisms to promote organic decomposition. They are: Ammonia Nitrogen (NH_3), mg/l as N; Kjeldahl Nitrogen (TKN), mg/l as N; Nitrate Nitrogen (NO_3), mg/l as N; Total Phosphate (TP), mg/l as P; Ortho Phosphate (OP), mg/l as P.

Ocean Discharge--Discharge of wastewater into an ocean.

Oncogenic--The property to produce tumors (not necessarily cancerous) in tissues (see Carcinogen).

Opacity--The ratio of transmitted to incident light.

Organo-Nitrogen Others Pesticide Structural Group--Alkylamine hydrochloride, Benzethonium chloride, Dazomet, Diphenylamine, Dodine, Etridiazole, Hyamine 2389, Hyamine 3500, Kathon 886, Lethane 384, Metasol DGH, Methyl benzethonium chloride, Octhilinone, PBED, Thiabendazole, Triadimefon, Tricyclazole.

Organo-Sulfur Pesticide Structural Group--EXD, HPTMS, Propargite, Sulfoxide, Vancide PA.

Ovicide--A chemical that destroys an organism's eggs.

Patent--An official document issued by the U.S. Office of Patents conferring an exclusive right or privilege to produce, use, or sell a pesticide for a specified period of time.

Pathogen--Any disease-producing organism or virus.

PCB--Polychlorinated biphenyl.

Pesticide--Any technical grade ingredient used for controlling, preventing, destroying, repelling, or mitigating any pest. See Section III for classes of pesticides covered; see Section XVIII--Appendix 3 for individual pesticides covered.

Pesticide (Priority Pollutant)--Aldrin; Dieldrin; Chlordane; 4,4'-DDT; 4,4'-DDE; 4,4'-DDD; a-endosulfan-Alpha; b-endosulfan-Beta; endosulfan sulfate; endrin; endrin aldehyde; heptachlor; heptachlor epoxide; a-BHC-Alpha; b-BHC-Beta; r-BHC-Gamma; g-BHC-Delta; Toxaphene.

pH--pH is a measure of the acidity or alkalinity of a water sample. It is equal to the negative log of the hydrogen ion concentration.

Phenols (Priority Pollutant)--Phenol; 2-Chlorophenol; 2,4-Dichlorophenol; 2,4,6-Trichlorophenol; Pentachlorophenol; 2-Nitrophenol; 4-Nitrophenol; 2,4-Dinitrophenol; Parachlorometa cresol; 4,6-Dinitro-o-cresol; 2,4-Dimethylphenol.

Pheromones--Highly potent insect sex attractants produced by the insects. For some species, laboratory-synthesized pheromones have been developed for trapping purposes.

Phosphate and Phosphonate Pesticide Structural Group--Dichlorvos, Mevinphos, Monocrotophos, Naled, Stirofos.

Phosphorothioate and Phosphorodithioate Pesticide Structural Group--Aspon, Azinphos methyl, Bolstar, Carbophenothion, Chlorpyrifos, Chlorpyrifos methyl, Coumaphos, Cythioate, Demeton, Demeton-o, Demeton-s, Diazinon, Dichlofenthion, Dioxathion, Disulfoton, EPN, Ethion, Ethoprop, Famphur, Fenitrothion, Fensulfothion, Fenthion, Fonofos, Malathion, Merphos, Oxydemeton, Parathion ethyl, Parathion methyl, Phorate, Phosmet, Ronnel, Temephos, Terbufos, Thionazin, Trichloronate, Tokuthion.

Phosphorus-Nitrogen Pesticide Structural Group--Acephate, Bensulide, Glyphosate, Mephosfolon, Methamidophos, Phosfolan.

Phthalate Esters (Priority Pollutant)--Bis(2-ethylhexyl)phthalate; Butyl benzyl phthalate; Di-n-butyl phthalate; Di-n-octyl phthalate; Diethyl phthalate; Dimethyl phthalate.

Phytotoxic--Poisonous to plants.

Piscicide--Chemical used to kill fish.

Polychlorinated Biphenyl's (Priority Pollutant)--PCB-1242; PCB-1254; PCB-1221; PCB-1232; PCB-1248; PCB-1260; PCB-1016.

Polynuclear Aromatic Hydrocarbons (Priority Pollutant)--Benzo(a)anthracene; Benzo(a)pyrene; 3,4-Benzofluoranthene; Benzo(k)fluoranthene; Chrysene; Acenaphthylene; Anthracene; Benzo(ghi)perylene; Fluorene; Phenathrene; Dibenzo(a,h)anthracene; Indeno(1,2,3-cd) pyrene; Fluoranthene; Naphthalene; 2-Chloronaphthalene; Acenaphthene.

Polyploidy--Exhibiting entire extra sets of chromosomes with three or more genomes.

Postemergence--After emergence of the specified weed or crop.

POTW--Publicly owned treatment works.

ppb--Parts per billion (equal micrograms per liter, ug/l, when the specific gravity is one).

ppm--Parts per million (equal milligrams per liter, mg/l, when the specific gravity is one).

ppt--Parts per trillion (equal nanograms per liter, ng/l, when specific gravity is one).

Pre-emergence--Refers to the time before sprouting from the soil of a specific weed or crop.

Primary Significance--Pollutants are of primary significance if they are proposed for regulation due to their deleterious effects on humans and the environment.

Primary Treatment--The first major treatment in a wastewater treatment works. In the classical sense, it normally consists of clarification. As used in this document, it generally refers to treatment steps preceding biological treatment.

Priority Pollutant--Those compounds specified as an outgrowth of the 1976 Consent Decree as listed in Section XVIII--Appendix 1.

Process Wastewater--Any aqueous discharge which results from or has had contact with the manufacturing process. For purposes of this study only wastewater from the final synthesis step in the manufacture of pesticide active ingredients is included, in addition to the following: (1) Wastewater from vessel-floor washing in the immediate manufacturing area; (2) Stormwater runoff from the immediate manufacturing area; (3) Wastewater from air pollution scrubbers utilized in the manufacturing process or in the immediate manufacturing area.

psi--Pound per square inch.

QA/QC--Quality Assurance/Quality Control.

Quaternary Ammonium Salt--Chemical compound having a chlorine or bromine ion attached to a nitrogen atom with four carbon-nitrogen bonds. May be used as algicides, bactericides, piscicides, etc.

Raw Waste Load--The quantity of flow or pollutant in wastewater prior to a treatment process.

Repellent (insects)--Substance used to repel ticks, chiggers, gnats, flies, mosquitoes, and fleas.

Resin Adsorption--A method of treating wastewater in which a resin material removes organic matter by adherence on the surface of solid bodies.

Risk Level--The population size on which it is estimated that one additional case of cancer will be reported due to the daily consumption of water and edible aquatic organisms.

Rodenticide--Pesticide applied as a bait, dust, or fumigant to destroy or repel rodents and other animals, such as moles and rabbits.

rpm--Revolution per minute.

Sanitary Wastewater--Wastewater discharging from sanitary conveniences such as toilets, showers, and sinks.

Sec--Second.

Secondary Significance--Pollutants are of secondary significance if they are not proposed for regulation, but are specified to be considered on a case-by-case basis for potential deleterious effects on humans and the environment.

Secondary Treatment--The second major step in a waste treatment system. As used in this document, the term refers to biological treatment.

Segregated Wastewater Stream--A wastewater stream generated from part or all of one pesticide process.

Slimicide--Chemical used to prevent slimy growth, as in wood-pulping processes for manufacture of paper and paperboard.

Sludge--The accumulated solids separated from liquids, such as water or wastewater, during processing.

Spray Evaporation--A method of wastewater disposal in which the water in a holding lagoon equipped with spray nozzles is sprayed into the air to expedite evaporation.

Sq. ft.--Square foot.

Steam Stripping--An operation in which relatively volatile components are transferred from a liquid mixture to the gas phase by passage of steam through the liquid.

Synergism--Increased activity resulting from the effect of one chemical to another.

Systemic--Compound that is absorbed and translocated throughout the plant or animal.

TCDD (Priority Pollutant)--TCDD(2,3,7,8-tetrachlorodibenzo-p-dioxin).

TDS--Total dissolved solids.

Teratogenic--Substance that causes physical birth defects in the offspring following exposure of the pregnant female.

Tertiary Treatment--The third major step in a waste treatment facility. As used in this document, the term refers to treatment processes following biological treatment.

Thiocarbamate Pesticide Structural Group--Amobam, AOP, Aquatreat DNM 30, Busan 40, Busan 85, Butylate, Carbam S, Cycloate, EPTC, KN Methyl, Metham, Nabam, Pebulate, Vernolate.

TKN--Total Kjeldahl nitrogen.

TLM--Median tolerance limit; the concentration in the environment of a toxic substance at which only 50 percent of the test organisms survive.

TOC--Total organic carbon is a measure of the organic contamination of a water sample. It has an empirical relationship with the biochemical and chemical oxygen demands.

TOD--Total oxygen demand.

Toxic--Poisonous to living organisms.

Treatment Technology--Any pretreatment or end-of-line treatment unit which is utilized in conjunction with process wastewater. The unit may be employed at any point from the process wastewater source to final discharge from plant property.

Triazine Pesticide Structural Group--Ametryne, Anilazine, Atrazine, Cyanazine, Hexazinone, Metribuzin, Prometon, Prometryn, Propazine, Simazine, Simetryne, Terbuthylazine, Terbutryn, Vancide TH.

TSS--Total suspended solids.

ug--Microgram.

Upset--An upset, sometimes called an excursion, is unintentional noncompliance occurring for reasons beyond the reasonable control of the permittee.

Uracil Pesticide Structural Group--Bromacil, Terbacil.

Urea Pesticide Structural Group--Diuron, Fenuron, Fenuron-TCA, Fluometuron, Linuron, Monuron, Monuron-TCA, Neburon, RH 787, Siduron, Tebuthiuron.

Volatile Aromatics (Priority Pollutant)--Benzene; Toluene; Ethyl benzene; Chlorobenzene; 1,2-Dichlorobenzene; 1,3-Dichlorobenzene; 1,4-Dichlorobenzene, 1,2,4-Trichlorobenzene; Hexachlorobenzene.

VSS--Volatile suspended solids.

Wastewater--See process wastewaters.

Wet Scrubber--An air pollution control device which involves the wetting of particles in an air stream and the impingement of wet or dry particles on collecting surfaces, followed by flushing.

Zero Discharge--The prevention of process wastewater from point sources entering navigable waters either directly or indirectly through publicly owned treatment works.

SECTION XX

CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
acre	ac	0.405	ha	hectares
acre-feet	ac ft	1233.5	cu m	cubic meters
British Thermal Unit	BTU	0.252	kg cal	kilogram-calories
British Thermal Unit/pound	BTU/lb	0.555	kg cal/kg	kilogram calories per kilogram.
cubic feet per minute	cfm	0.028	cu m/min	cubic meters per minute
cubic feet per second	cfs	1.7	cu m/min	cubic meters per minute
cubic feet	cu ft	0.028	cu m	cubic meters
cubic feet	cu ft	28.32	l	liters
cubic inches	cu in	16.39	cu cm	cubic centimeters
degree Fahrenheit	°F	0.555(°F - 32)*	°C	degree Centigrade
feet	ft	0.3048	m	meters
gallon	gal	3.785	l	liter
gallon per minute	gpm	0.0631	l/sec	liters per second
gallon per ton	gal/ton	4.173	l/kkg	liters per metric ton

* Actual conversion, not a multiplier

CONVERSION TABLE

Multiply (English Units)		By	To Obtain (Metric Units)	
English Unit	Abbreviation	Conversion	Abbreviation	Metric Unit
horsepower	hp	0.7457	kw	kilowatts
inches	in	2.54	cm	centimeters
pounds per square inch	psi	0.06803	atm	atmospheres (absolute)
million gallons per day	MGD	3.7×10^{-3}	cu m/day	cubic meters per day
pounds per square inch (gauge)	psi	(0.06805 psi + 1 TM)	atm	atmospheres
pounds	lb	0.454	kg	kilograms
pounds	lb	454,000	mg	milligrams
ton	ton	0.907	kkg	metric ton
mile	mi	1.609	km	kilometer
square feet	ft^2	0.0929	m^2	square meters

* Actual conversion, not a multiplier.

SECTION XXI

APPENDICES

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SECTION XXI--APPENDIX 1

PRIORITY POLLUTANTS BY GROUP

Benzidines

1. Benzidine
2. 3,3'-Dichlorobenzidine

Chlorinated Ethanes and Ethylenes

3. Chloroethane
4. 1,1-Dichloroethane
5. 1,2-Dichloroethane
6. 1,1-Dichloroethylene
7. Hexachloroethane
8. 1,1,2,2-Tetrachloroethane
9. Tetrachloroethylene
10. 1,2-Trans-dichloroethylene
11. 1,1,1-Trichloroethane
12. 1,1,2-Trichloroethane
13. Trichloroethylene
14. Vinyl chloride (Chloroethylene)

Cyanides

15. Cyanide

Dichloropropane and Dichloropropene

16. 1,2-Dichloropropane
17. 1,3-Dichloropropene

Dienes

18. Hexachlorobutadiene
19. Hexachlorocyclopentadiene

Haloethers

20. Bis(2-chloroethoxy) methane
21. Bis(2-chloroethyl) ether
22. Bis(2-chloroisopropyl) ether
23. Bis(chloromethyl) ether*
24. 4-Bromophenyl phenyl ether
25. 2-Chloroethyl vinyl ether
26. 4-Chlorophenyl phenyl ether

Halomethanes

27. Bromoform (Tribromomethane)
28. Carbon tetrachloride (Tetrachloromethane)
29. Chlorodibromomethane
30. Chloroform (Trichloromethane)
31. Dichlorobromomethane
32. Dichlorodifluoromethane*
33. Methyl bromide (Bromomethane)
34. Methyl chloride (Chloromethane)
35. Methylene chloride (Dichloromethane)
36. Trichlorofluoromethane*

Metals

37. Antimony
38. Arsenic
39. Beryllium
40. Cadmium
41. Chromium
42. Copper
43. Lead
44. Mercury
45. Nickel
46. Selenium
47. Silver
48. Thallium
49. Zinc

Miscellaneous Priority Pollutants

50. Acrolein
51. Acrylonitrile
52. Asbestos
53. 1,2-Diphenylhydrazine
54. Isophorone

Nitrosamines

55. N-nitrosodimethylamine
56. N-nitrosodiphenylamine
57. N-nitrosodi-n-propylamine

SECTION XXI--APPENDIX 1

PRIORITY POLLUTANTS BY GROUP

(Continued, Page 2 of 3)

Nitrosubstituted Aromatics

58. 2,4-Dinitrotoluene
59. 2,6-Dinitrotoluene
60. Nitrobenzene

Pesticides

61. Aldrin
62. a-BHC-Alpha
63. b-BHC-Beta
64. r-BHC-Gamma (Lindane)
65. g-BHC-Delta
66. Chlordane
67. Dieldrin
68. 4,4'-DDD (p-p'-TDE)
69. 4,4'-DDE (p-p'-DDX)
70. 4,4'-DDT
71. a-Endosulfan-Alpha
72. b-Endosulfan-Beta
73. Endosulfan sulfate
74. Endrin
75. Endrin aldehyde
76. Heptachlor
77. Heptachlor epoxide
78. Toxaphene

Phenols

79. 2-Chlorophenol
80. 2,4-Dichlorophenol
81. 2,4-Dimethylphenol
82. 4,6-Dinitro-o-cresol
83. 2,4-Dinitrophenol
84. 2-Nitrophenol
85. 4-Nitrophenol
86. Parachlorometa cresol
87. Pentachlorophenol
88. Phenol
89. 2,4,6-Trichlorophenol

Polychlorinated Biphenyls

96. PCB-1242 (Arochlor 1242)
97. PCB-1254 (Arochlor 1254)
98. PCB-1221 (Arochlor 1221)
99. PCB-1232 (Arochlor 1232)
100. PCB-1248 (Arochlor 1248)
101. PCB-1260 (Arochlor 1260)
102. PCB-1016 (Arochlor 1016)

Polynuclear Aromatic Hydrocarbons

103. Acenaphthylene
104. Acenaphthene
105. Anthracene
106. Benzo(a)anthracene (1,2-Benzanthracene)
107. Benzo(a)pyrene (3,4-Benzopyrene)
108. 3,4-Benzofluoranthene
109. Benzo(ghi)perylene (1,12-Benzoperylene)
110. Benzo(k)fluoranthene (11,12-Benzofluoranthene)
111. 2-Chloronaphthalene
112. Chrysene
113. Dibenzo(a,h)anthracene (1,2,5,6-Dibenzanthracene)
114. Fluoranthene
115. Fluorene
116. Indeno(1,2,3-cd)pyrene (2,3-o-Phenylenepyrene)
117. Naphthalene
118. Phenanthrene
119. Pyrene

TCDD

120. TCDD (2,3,7,8-Tetrachloro-dibenzo-p-dioxin)

SECTION XXI--APPENDIX 1

PRIORITY POLLUTANTS BY GROUP

(Continued, Page 3 of 3)

Phthalate Esters	Volatile Aromatics
90. Bis(2-ethylhexyl) phthalate	121. Benzene
91. Butyl benzyl phthalate	122. Chlorobenzene
92. Diethyl phthalate	123. 1,2-Dichlorobenzene
93. Dimethyl phthalate	124. 1,3-Dichlorobenzene
94. Di-n-butyl phthalate	125. 1,4-Dichlorobenzene
95. Di-n-octyl phthalate	126. Ethylbenzene
	127. Hexachlorobenzene
	128. 1,2,4-Trichlorobenzene
	129. Toluene

* Classification as a priority pollutant discontinued by EPA.

SECTION XXI--APPENDIX 2

BPT EFFLUENT LIMITATIONS GUIDELINES

The following pesticides were excluded from BPT regulations according to the April 25, 1978 Federal Register:

Allethrin	Naphthalene acetic acid
Benzyl benzoate	1,8-Naphthalic anhydride
Biphenyl	Phenylphenol
Bisethylxanthogen*	Piperonyl butoxide
Chlorophacinone	Propargite
Coumafuryl	Quinomethionate
Dimethyl phthalate	Resmethrin
Diphacinone	Rotenone
Endothall acid	Sodium phenylphenate
EXD (Herbisan)*	Sulfoxide
Gibberellic acid	Triazine compounds (both symmetrical and asymmetrical)
Glyphosate	
Methoprene	Warfarin and similar anticoagulants

* Although originally listed as two compounds, it has been determined that the two are one in the same. EXD is the common name used throughout this regulation; bisethylxanthogen is a trade name.

The following pesticides were regulated for the direct discharge to navigable waters of BOD, COD, TSS, Pesticides, and pH according to the September 29, 1978 Federal Register as listed below:

Aldrin	Dicamba	Mexacarbate
Aminocarb	Dichloran (DCNA)	Mirex
Azinphos methyl	Dicofol	Monuron
Barban	Dieldrin	Monuron-TCA
BHC	Disulfoton	Neburon
Captan	Diuron	Parathion ethyl
Carbaryl	Endosulfan	Parathion methyl
Chlordane	Endrin	PCNB
Chlorpropham	Fenuron	Perthane
2,4-D	Fenuron-TCA	Propham
DDD	Heptachlor	Propoxur
DDE	Lindane	Siduron
DDT	Linuron	Silvex
Demeton-O	Malathion	SWEP
Demeton-S	Methiocarb	2,4,5-T
Diazinon	Methoxychlor	Trifluralin
		Toxaphene

SECTION XXI--APPENDIX 2

BPT EFFLUENT LIMITATIONS GUIDELINES

(Continued, Page 2 of 2)

All other manufactured pesticides were regulated for the direct discharge to navigable waters of BOD, COD, TSS, and pH according to the September 29, 1978 Federal Register as listed below:

Subcategory*	Effluent Characteristic	Effluent Limitations: Average of Daily Values for 30 Consecutive Days	Effluent Limitations: Daily Maximum
1	BOD_5	1.6	7.4
	COD	9.0	13.0
	TSS	1.8	6.1
	Pesticide Chemicals	0.0018	0.010
	pH†	--	--
2	NO DISCHARGE OF PROCESS WASTEWATER POLLUTANTS		
3	NO DISCHARGE OF PROCESS WASTEWATER POLLUTANTS		

Note: All units are kg/kkg

* Subcategory 1: Organic Pesticide Chemicals Manufacturing
  Subcategory 2: Metallo-Organic Pesticide Chemicals Manufacturing
  Subcategory 3: Pesticide Chemicals Formulating and Packaging

† The pH shall be between the values of 6.0 to 9.0

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

Common Name	Chemical Name	Subcategory
1. Acephate (Orthene)	O,S-Dimethyl acetylphosphoramidothioate	5
2. Alachlor (Lasso)	2-Chloro-2',6'-diethyl-N-(methoxymethyl) acetanilide	2
3. Aldicarb (Temik)	2-Methyl-2-(methylthio)-propionaldehyde-o-(methylcarbomoyl) oxime	1
4. Alkylamine hydrochloride	Alkylamine hydrochloride	11
5. Ametryne (Evik)	2-Ethylamino-4-isopropylamino-6-methylthio-1,3,5-triazine	10
6. Amobam	Diammonium ethylenebisdithiocarbamate	11
7. Anilazine (Dyrene)	2,4-Dichloro-6-(2-chloroanilino)-1,3,5-triazine	10
8. [AOP] (Ambam oxidation product)	Ethylene bis (dithiocarbamic acid) bimolecular and trimolecular cyclic anhydrosulfides and disulfides	2
9. (Aquatreat DNM 30)	15% Sodium dimethyl dithiocarbamate 15.0% Disodium ethylene bisdithiocarbamate	3
10. (Aspon)	tetra-n-Propyl dithiopyrophosphate	2
11. Atrazine (Aatrex)	2-Chloro-4-ethylamino-6-isopropylamino-1,3,5-triazine	1, 10

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 2 of 23)

Common Name	Chemical Name	Subcategory
12. Azinphos methyl (Guthion)	0,0-Diethyl S-[4-oxo-1,2,3-benzotriazin-3(4H)-ylmethyl] phosphorodithioate	9
13. Barban (Carbyne)	4-Chlorobut-2-butynyl-m-chlorocarbanilate	11
14. 1,1'-(2-butenylene)bis (3,5,7-triaza-1-azo (niaadiamantane chloride) [BBTAC]	1,1'-(2-Butenylene)bis(3,5,7-triaza-1-azo niaadamantane chloride)	11
15. Bendiocarb (Ficam)	2,3-Isopropylidenedioxyphenyl methylcarbamate	1
16. Benfluralin (Benefin)	N-Butyl-N-ethyl-2,6-dinitro-4-trifluoro-methylaniline	2
17. Benomyl (Benlate)	Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate	1
18. Bensulide (Prefar)	S-(0,0-Diisopropyl phosphorodithioate) ester of N-(2-mercaptoethyl)benzene sulfonamide	2
19. Bentazon (Basagran)	3-Isopropyl-1H-2,1,3-benzothiadiazion-(4) 3H-one 2,2-dioxide	2
20. Benzethonium chloride (Hyamine 1622)	Benzyldimethyl[2-<2-(p-1,1,3,3-tetramethylbutylphenoxy)ethoxy>ethyl]ammonium chloride	2
21. Benzyl bromoacetate (Merbac 35)	Benzyl bromoacetate	2
22. Bifenox (Modown)	Methyl 5-(2,4-dichlorophenyl) 2-nitrobenzoate	2

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 3 of 23)

Common Name	Chemical Name	Subcategory
23. Biphenyl (Diphenyl)	Diphenyl	1, 11
24. (Bolstar) Sulprofos	O-Ethyl O-[4(methylthio)phenyl]--s-propyl phosphorodithioate	2
25. Bromacil (Hyvar)	5-Bromo-3-sec-butyl-6-methyl-uracil	2
26. Bromoxynil (Brominal)	3,5-Dibromo-4-hydroxybenzonitrile	2
27. Bromoxynil octanoate	2,6-Dibromo-4-cyanophenyl octanoate	2
28. (Busan 40)	Potassium N-hydroxymethyl--N-Methyldithio carbamate	1
29. (Busan 85)	Potassium dimethyldithio carbamate	1
30. (Busan 90)	2-Bromo-4^{1}-hydroxyacetophenone	2
31. Butachlor (Machete)	N-(Butoxymethyl)-2-chloro-2',6'--diethylacetanilide	2
32. Butylate (Sutan)	S-Ethyl N, N-diisobutylthiocarbamate	2
33. Captafol (Difolatan)	N-(1,1,2,2-Tetrachloroethylthio) tetrahydrophthalimide	1
34. Captan (Orthocide 406)	N-[(Trichloromethyl)thio]-4--cyclohexene-1,2-dicarboximide	9
35. (Carbam-S) (Sodam)	Sodium dimethyldithiocarbamate	1
36. Carbaryl (Sevin)	1-Naphthyl N-methylcarbamate	9

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 4 of 23)

Common Name	Chemical Name	Subcategory
37. Carbendazim	2-(Methoxycarbonylamino)benzimidazol	2
38. Carbofuran (Furadan)	2,3-Dihydro-2,2-dimethyl-7--benzofuranyl methylcarbamate	1
39. Carbophenothion (Trithion)	S-[(p-Chlorophenylthio)-methyl] 0,0-diethyl phosphorodithioate	2
40. (CDN)	4-Chloro-3,5-dinitrobenzenotrifluoride	2
41. Chloramben (Amiben)	3-Amino-2,5-dichlorobenzoic acid	2
42. Chlordane* (Octachlor)	1,2,4,5,6,7,8,8-Octachloro--2,3,3a,4,7,7a-hexhydro--4,7-methanoindene	8
43. Chlorobenzene*	Monochlorobenzene	2
44. Chlorobenzilate (Acaraben)	Ethyl 4,4'-dichlorobenzilate	2
45. Chlorothalonil (Daconil 2787)	2,4,5,6-Tetrachloroisophthalonitrile	4
46. Chloropicrin (Larvacide, Nemax)	Trichloronitromethane	1, 11
47. Chlorpyrifos (Dursban)	0,0-Diethyl 0-(3,5,6-trichloro-2-pyridyl)phosphorothioate	2
48. Chlorpyrifos methyl	0,0-Dimethyl 0-(3,5,6-trichloro-2-pyridyl) phosphorothioate	2

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 5 of 23)

Common Name	Chemical Name	Subcategory
49. Coumaphos (Co-Ral)	0-(3-Chloro-4-methyl-2-oxo--2H-1-benzopyran-7-yl) 0,0-diethyl phosphorothioate	1
50. Cyanazine (Bladex)	2-[(4-Chloro-6-(ethylamino)--S-triazine-2-yl)amino]-2--methylpropionitrite	10
51. Cycloate (Ro-Neet)	S-Ethyl ethylcyclohexylthiocarbamate	2
52. Cycloheximide (Actidione)	3[2-(3,5-Dimethyl-2-oxocyclohexyl)-2-hydroxyethyl] glutarimide	2
53. Cycloprate	Hexadecylcyclopropane carboxylate	2
54. Cyhexatin	Tricyclohexytin hydroxide	2
55. Cythioate (Probam)	0,0-Dimethyl 0-p-sulfamoylphenyl phosphorothioate	2
56. 2,4-D	2,4-Dichlorophenoxyacetic acid	9
57. 2,4-D isobutyl ester	2,4-Dichlorophenoxyacetic acid, technical mixture: Isobutyl ester, 60% N-butyl ester, 40%	2
58. 2,4-D isooctyl ester	2,4-Dichlorophenoxyacetic acid isooctyl ester 3,4-Dimethylhexanol, 20% 3,5-Dimethylhexanol, 30% 4,5-Dimethylhexanol, 30% 3-Methylheptanol, 15% 5-Methylheptanol, 5%	2, 11

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 6 of 23)

Common Name	Chemical Name	Subcategory
59. 2,4-D salt	2,4-Dichlorophenoxyacetic acid dimethylamine salt	11
60. Dalapon (Dowpon)	2,2-Dichloropropionic acid	1
61. Dazomet (Thiadiazin)	Tetrahydro-3,5-dimethyl-1, 3,5-thiadiazine-2-thione	1
62. 2,4-DB	4-(2,4-Dichlorophenoxy)-butyric--acid	2
63. 2,4-DB isobutyl ester	4-(2,4-Dichlorophenoxy)-butyric--acid isobutyl ester	2
64. 2,4-DB isooctyl ester	4-(2,4-Dichlorophenoxy)-butyric--acid isooctyl ester	2
65. DBCP (Dibromochloropropane, Nemagon)	1,2,Dibromo-3-chloropropane and related halogenated C3 hydrocarbons	1
66. DCNA (Dichloran, Botran)	(2,6 Dichloro-4,nitroaniline)	9
67. DCPA (Dacthal)	Dimethyl 2,3,5,6-tetrachloro terephthalate	2
68. DDT*	Dichlorodiphenyl trichloroethane	9
69. Deet	NN-Diethyl-m-toluamide	2
70. Demeton (Systox)	Mixture of 0,0-diethyl-S(and 0)-[2-(ethylthio)ethyl] phosphorothioates	2
71. Diazinon (Spectracide)	0,0-Diethyl 0-(2-isopropyl-b-methyl-4-pyrimidinyl) phosphorothioate	9
72. Dicamba (Banvel D)	2-Methoxy-3,b-dichlorozbenzoic acid	9

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 7 of 23)

Common Name	Chemical Name	Subcategory
73. Dichlofenthion (Nemacide)	0-2,4-Dichlorophenyl 0,0-diethyl phosphorothioate	2
74. Dichlorobenzene, ortho* (ODB)	1,2-Dichlorobenzene	2
75. Dichlorobenzene, para* (PDB)	1,4-Dichlorobenzene	2
76. Dichloroethyl ether* (Chlorex)	Bis(2-chloroethyl) ether	11
77. Dichlorophen	2,2'-Methylene bis(4-chlorophenol)	2
78. Dichlorophen salt	Sodium salt of 2,2'-methylene bis(4-chlorophenol)	11
79. D-D (Dichloropropane-dichloropropene mixture)	(60-66%) 1,3-Dichloropropene & (30-35%) 1,2-Dichloropropane & other constituents	11
80. Dichloropropene (Telone)*	1,3-Dichloropropene	11
81. Dichlorprop (2,4-DP)	2-(2,4-Dichlorophenoxy)--propionic acid	2
82. Dichlorvos (DDVP)	2,2-Dichlorovinyl dimethyl phosphate	1
83. Dienochlor (Pentac)	Perchlorobi (cyclopenta-2, 4-dien-1-yl)	5
84. Dimethoxane (Dioxin)	6-Acetyl-2,4-dimethyl-m--dioxane	1
85. Dinocap (Karathane)	2-(1-Methylheptyl)-4,6--dinitrophenyl crotonate	1
86. Dinoseb (DNBP)	2-(sec-Butyl)-4,6-dinitrophenol	1

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 8 of 23)

Common Name	Chemical Name	Subcategory
87. Dioxathion (Delnav)	s,s'-p-Dioxane-2,3-diyl 0, 0-diethyl phosphorodithioate (cis and trans isomers)	1
88. Diphacinone (Diphacin)	2-Diphenylacetyl-1,3-indandione	1
89. Diphenamid (Enide)	N,N-Dimethyl-2,2-diphenylacetamide	2
90. Diphenylamine (DFA)	Diphenylamine	2
91. Disulfoton (Di-Syston)	0,0-Diethyl S-[2-(ethylthio)-ethyl] phosphorodithioate	9
92. Diuron (DCMU)	3-(3,4-Dichlorophenyl)-1-dimethylurea	9
93. Dodine (Carpene)	n-Dodecylguanidine acetate	6
94. (Dowicil 75)	1-(3-Chlorallyl)-3,5,7-triaza--1-azonia-ad mentane	11
95. Endothall (Endothal)	7-Oxabicyclo(2,2,1)heptane-2, 3-dicarboxylic acid monohydrate	1
96. Endrin*	1,2,3,4,10,10-Hexachloro-b, 7-epoxy-1,4,4a,5,6,7,8,8a--octahydro-exo-1,4-exo-5, 8-dimethanonaphthalene	9
97. EPN	0-Ethyl 0-p-nitrophenyl phenyl phosphonothioate	2
98. EPTC (Eptam)	S-Ethyldipropylthiocarbamate	2
99. Ethalfiuralin (Sonalan)	N-Ethyl-N-(2-methyl-2-propenyl) -2,6-dinitro-4-(trifluoromethyl) aniline	2

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 9 of 23)

Common Name	Chemical Name	Subcategory
100. Ethion	0,0,0',0-Tetraethyl S,S'-methylene bisphosphorodithioate	2
101. Ethoprop (Mocap)	0-Ethyl S,S,'dipropyl phosphorodithioate	11
102. Ethoxyquin 66%	1,2-Dihydro-6-ethoxy-2,2,4 trimethyl quinoline 60-66%	2
103. Ethoxyquin 86%	1,2-Dihydro-6-ethoxy-2,2,4 trimethyl quinoline 80-86%	2
104. Ethylene dibromide (EDB)	1,2-Dibromoethane	1
105. Etridiazole (Terrazole)	5-Ethoxy-3-trichloromethyl-1,2,4-thiadiazole	2
106. EXD (Bisethylxanthogen) (Herbisan)	Diethyl dithiobis(thionoformate)	1
107. Famphur (Warbex)	0-[p(Dimethylsulfamoyl)phenyl] 0,0-dimethyl phosphorothioate	2
108. Fenarimol	a-(2-Chlorophenyl)-a-(4-chlorophenyl)-5-pyrimidine-methanol	1
109. Fenitrothion (Sumithion)	0,0-Dimethyl 0-(4-nitro-m-tolyl) phosphorothioate	7
110. Fensulfothion (Dasanit)	0,0-Diethyl 0-[p(methylsulfinyl) phenyl]phosphorothioate	5
111. Fenthion (Baytex)	0,0-Dimethyl 0-[4-(methyl-thio)--m-tolyl] phosphorothioate	2
112. Fentin hydroxide (Du-Ter)	Triphenyltin hydroxide	2
113. Ferbam (Fermate)	Ferric dimethyldithiocarbamate	1

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 10 of 23)

Common Name	Chemical Name	Subcategory
114. Fluchloralin (Basalin)	N-Propyl-N-(2-chloroethyl)-a, a,a-trifluoro-2,6-dinitro-p--toluidine	2
115. Fluoridone (EL-171)	1-Methyl-3-phenyl-5[3-(trifluor-omethyl)phenyl]-4-(1H)-pyridinone	2
116. Fluometuron (Cotoran)	1,1-Dimethyl-3-(3-trifluoromethyl-phenyl)urea	4
117. Fluoroacetamide	Fluoroacetamide	11
118. Folpet (Phaltan)	N-(Trichloromethylthio)-phthal-imide	1
119. Fonofos (Dyfonate)	O-Ethyl S-phenyl ethyl-phosphono-dithioate	2
120. (Giv-gard)	Beta-bromo-beta nitrostyrene	2
121. Glyodin	2-Heptadecyl-2-imidazoline acetate	11
122. Glyphosate (Roundup)	N-(Phosphonomethyl)glycine	2
123. 2-[(Hydroxymethyl) amine]ethanol [HAE]	2-[(Hydroxymethyl)amine] ethanol	1
124. 2-[(Hydroxymethyl) amine]-2-methyl propanol [HAMP]	2-[(Hydroxymethyl)amine] -2-methyl propanol	1
125. Heptachlor*	1,4,5,6,7,8,8-Heptachloro-3a,4, 7,7a-tetrahydro-4,7-methano-indene	9
126. Hexachlorophene (Nabac)	2-2'-Methylene bis (3,4,6--trichlorophenol	2

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 11 of 23)

Common Name	Chemical Name	Subcategory
127. Hexazinone	3-Cyclohexyl-6-(dimethylamino) -1-methyl-1,3,5-triazine-2, 4(1H,3H)-dione	2
128. HPTMS	S-(2-Hydroxy propyl) thiomethane Sulfonate	11
129. (Hyamine 2389)	Methyl dodecyl benzyl trimethyl ammonium chloride, 80% and Methyl dodecyl xylylene bis(tri-methyl ammonium chloride)20%	2
130. (Hyamine 3500)	n-Alkyl (50% C14,40% C12,10% C16) dimethyl benzyl ammonium chloride	2
131. Isopropalin (Paarlan)	2,6-Dinitro-N,N-dipropylcumidine	1
132. (Kathon 886)	5-Chloro-2-methyl 4-isothiazolin--3-one and 2 methyl 4-isothiazolin--3-one	2
133. Kinoprene	Prop-2-ynyl(±)-(E,E)-3,7,11--trimethyldodeca-2,4-dienoate	2
134. (KN methyl)	Potassium N-methyl dithiocarbamate	1
135. (Lethane 384)	b-Butoxy-B'thiocyanodiethyl ether	4
136. Linuron (Afolan, Lorox)	3-(3,4-Dichlorophenyl)-1-methoxy--1-methylurea	9
137. Malathion (Mercaptothion, Cythion)	Diethyl mercaptosuccinate S-ester with 0,0-dimethyl phosphorodithioate	8
138. Maleic hydrazide	1,2-Dihydropyridazine-3,6-di-one	1

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 12 of 23)

Common Name	Chemical Name	Subcategory
139. Mancozeb (Dithane M-45)	Coordination product of maneb containing 16 to 20% Mn and 2.0 to 2.5% Zn (zinc) (maneb=manganous ethylene-1, 2-bis-dithiocarbamate)	3
140. Maneb (Manzate)	Manganous ethylene-1,2-bis--dithiocarbamate	3
141. MCPA	4-Chloro-2-methylphenoxy acetic acid	2
142. MCPA isooctyl ester	4-Chloro-2-methylphenoxy isooctly ester	2
143. MCPP	2-Methyl-4-chlorophenoxy propionic acid	2
144. Mephosfolan (Cytrolane)	P,P-Diethyl cyclic propylene ester of phosphonodithioimido--carbonic acid	2
145. (Merphos) (Folex)	Tributyl phosphorotrithioite	11
146. (Metasol DGH)	Dodecylguanidine HCl	6
147. (Metasol J-26)	N(1 Nitroethyl benzyl) ethylene diamine 25%	11
148. Metham (Vapam, SMDC)	Sodium N-methyldithio carbamate	1
149. Methamidophos (Monitor) (Tamaron)	O-S-Dimethyl phosphoroamido-thioate	2
150. Methomyl (Lannate)	S-Methyl N-[(methylcarbomoyl)--oxy]thioacetimidate	2

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 13 of 23)

Common Name	Chemical Name	Subcategory
151. Methoprene (Altosid)	Isopropyl (2E,4E)-11-methoxy-3, 7,11-trimethyl-1,4-dodecadi-enoate	1
152. Methoxychlor (Marlate)	2,2-Bis(p-methoxyphenyl)-1,1,1--trichloroethane	9
153. Methylbenzethonium chloride (Hyamine 10x)	Benzyldimethyl [2-<2-(p-1,1,3, 3-tetramethyl-butylcresoxy) -ethoxy>ethyl] ammonium chloride	2
154. Methyl bromide* (Metabrom)	Bromomethane	2
155. Methylene bisthiocyanate (Cytox)	Methylene bisthiocyanate	4
156. Metribuzin (Sencor)	4-Amino-6-tert-butyl-3-(methyl-thio)-1,2,4,triazine-5-one	10
157. Mevinphos (Phosdrin)	Methyl 3-hydroxy-alpha-croton-ate, dimethyl phosphate	1
158. (MGK 264)	N-(2-Ethylhexyl)bicyclo(2,2,1)--5-heptene-2,3-dicarboximide	2
159. (MGK 326)	Di-n-propyl isocinchomeronate	2
160. Molinate (Ordram)	S-Ethyl hexahydro-1H-azepine-1--carbothioate	2
161. Monocrotophos (Azodrin)	Dimethyl phosphate of 3-hydroxy-N-methyl-cis-crotonamide	5
162. Nabam (Dithane D-14)	Disodium ethylene bis(dithio-carbamate)	2
163. (Nabonate)	Disodium cyanodithio-imidocarbonate	6

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 14 of 23)

Common Name	Chemical Name	Subcategory
164. Naled (Dibrom)	1,2-Dibromo-2,2-dichloro-ethyl dimethyl phosphate	2
165. Napropamide (Devrinol)	2-(a-Naphthoxy)-N,N-diethyl-propionamide	2
166. Naptalam	N-1-Naphthylphtalamic acid	2
167. (Niacide)	Manganeous dimethyldithio-carbamate	1
168. Nitrofen (TOK)	2,4-Dichlorophenyl-p-nitrophenyl ether	2
169. (NMI)	2,6,Bis dimethylamine methyl cyclohexanone	2
170. Norflurazon (Evital)	4-Chloro-5-(methylamino)-2-(a, a,a-trifluoro-m-tolyl)-2H--pyridazinone	1
171. Octhilinone (RH-893)	2-n-Octyl-4-isothiazolin--3-one	1
172. Oryzalin (Surflan)	3,5-Dinitro-N4,N4-dipropyl-sulfanilamide	1
173. Oxamyl (Vydate)	Methyl n',n'-diomethyl-N-[(methyl-carbomoyl)oxy]-1 thio oxami-midate	1
174. Oxydemeton (Metasystox-R)	S-[2-(Ethylsufinyl)ethyl-0,0--dimethyl phosphorothioate	2
175. Oxyfluorfen (Goal)	2-Chloro-1-(3-ethoxy-4-nitro-phenoxy)-4-(trifluoromethyl) benzene	2
176. Paraquat	1,1'-Dimethyl-4,4'-bipyridalium ion	2

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 15 of 23)

Common Name	Chemical Name	Subcategory
177. Parathion ethyl	0,0-Diethyl-O-p-nitrophenyl phosphorothioate	8
178. Parathion methyl	0,0-Dimethyl O-p-nitro-phenyl phosphorothioate	8
179. PBED (Busan 77)	Poly[oxyethylene(dimethylimino) ethylene(dimethylimino)ethylene dichloride]	2
180. PCNB (Quintozene)	Pentachloronitrobenzene	9
181. PCP*	2,3,4,5,6-Pentachlorophenol	2
182. PCP salt	2,3,4,5,6-Potassium-pentachlorophenate	1
183. Pebulate (Tillman)	S-Propyl butylethylthiocarbamate	5
184. Permethrin (Ambush)	m-phenoxybenzyl (±)-cis, trans-3-(2,2-dichlorovinyl)--2,2-dimethylcyclopropane-carboxylate	1
185. Phenylphenol (Dowicide 1)	o-Phenylphenol	2
186. Phenylphenol sodium salt (Dowicide A)	Sodium o-phenylphenate	2
187. Phorate (Thimet)	0,0-Diethyl S-[(ethylthio)--methyl]phosphorodithioate	1
188. Phosfolan (Cyolane)	P,P-Diethyl cyclic ethylene ester of phosphonodithiomido--carbonic acid	2
189. Phosmet (Imidan)	0,0-Dimethyl-S-phthalimido--methyl phosphorodithioate	2

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 16 of 23)

Common Name	Chemical Name	Subcategory
190. Picloram (Trodon)	4-Amino-3,5,6,-trichloro--picolinic acid	4
191. Pindone (Pival)	2-Trimethylacetyl-1,3--indandione	2
192. Piperalin (Pipron)	3-(2-Methylpiperidino)propyl--3,4-dichlorobenzoate	2
193. Piperonyl butoxide (Butacide)	a-[2-(Butoxyethoxy-ethoxy] -4,5-methylenedioxy-2-propyl-toluene	1
194. (Polyphase antimildew)	3-Ido-2 propynyl butyl carbamate	1
195. Profluralin (Tolban)	N-Cyclopropylmethyl-2,6-dinitro -N-propyl-4-trifluoromethyl-aniline	2
196. Prometon (Pramitol)	2,4-Bis(isopropylamino)-6--methoxy-s-triazine	10
197. Prometryn (Caparol)	2,4-Bis(isopropylamino)-6-(methyl-thio)-S-triazine	10
198. Pronamide (Kerb)	3,5-Dichloro-N-(1,1-dimethyl-2--propynyl)benzamide	2
199. Propachlor (Ramrod)	2-Chloro-N-isopropylacetanilide	2
200. Propanil (Stam)	3,4-Dichloropropionanilide	2
201. Propargite (Omite)	2-(p-tert-Butylphenoxy)cyclo-hexyl 2-propynyl sulfite	1
202. Propazine (Milogard)	2-Chloro-4,6-bis(isopropylamino) -s-triazine	10
203. Propionic acid	Propanoic acid	1

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 17 of 23)

Common Name	Chemical Name	Subcategory
204. Pyrethrins	Standardized mixture of pyrethrins I and II (mixed esters of pyrethrolone	11
205. 8 Quinolinol citrate	8-Quinolinol citrate	1
206. 8 Quinolinol sulfate	8-Quinolinol sulfate	1
207. Resmethrin	(5-Benzyl-3-furyl)methyl-2,2-dimethyl-3-(2-methyl propenyl) cyclopropane carboxylate (approximately 70% trans, 30% Cis isomers)	10
208. RH 787 (Vacor)	N-3-Pyridylmethyl N'-nitrophenyl urea	2
209. Ronnel (Fenchlorphos)	0,0-Dimethyl 0-(2,4,5-trichlorophenyl)phosphorothioate	2
210. Rotenone	1,2,12,12a, Tetrahydro-2-isopropenyl-8,9-dimethoxy-[1]benzopyrano [3,4-b] furo [2,3-b] [1] benzopyran	2
211. Siduron (Tupersan)	1-(2-Methylcyclohexyl)-3-phenylurea	9
212. Silvex (Fenoprop)	2-(2,4,5-Trichlorophenoxy) propionic acid	9
213. Silvex isooctyl ester	Isooctyl ester of 2-(2,4 5-trichlorophenoxy)propionic acid	11
214. Silvex salt	Dimethyl amine salt of 2-(2,4,5-trichlorophenoxy) propionic acid	11
215. Simazine (Princep)	2-Chloro-4,5,6-bis(ethyl-amino)-s-triazine	10

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 18 of 23)

Common Name	Chemical Name	Subcategory
216. Simetryne (Gybon)	2-Methylthio-4,6-bis-ethylamino -s-triazine	10
217. Sodium monofluoroacetate	Sodium monofluoroacetate	1, 11
218. Stirofos (Tetrachlorvinphos)	2-Chloro-1-(2,4,5-trichlorophenyl) vinyl dimethyl phosphate	2
219. Sulfallate (CDEC)	2-Chloroally diethyldithio-carbamate	1
220. 2,4,5-T	2,4,5-Trichlorophenoxyacetic acid	9
221. TCMTB	2-[Thiocyanomethythio] benzothiazole	7
222. Tebuthiuron	1-(5-tert-Butyl-1,2,4-thia-diazol -2-yl)-1,3-dimethylurea	1
223. Temephos (Abate)	0,0-Dimethyl phosphorothioate 0,0-diester with 4,4'-thio-diphenol	2
224. Terbacil (Sinbar)	3(tert-Butyl)-5-chlor-6-methyl uracil	1
225. Terbufos (Counter)	5-tert-Butylthiomethyl 0,0-dimethyl phosphorodithioate	1
226. Terbuthylazine (GS 13529)	2-tert-Butylamino-4-chloro -6-ethylamino-1,3,5-triazine	10
227. Terbutryn (Igran)	2-(tert-Butylamino)-4- -(ethyl-amino)-6-(methylthio) -s-triazine	10
228. Thiabendazole (Mertect)	2-(4'-Thiazolyl) benzimidazole	4

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 19 of 23)

Common Name	Chemical Name	Subcategory
229. Thiofanox (DS-15647)	3,3-Dimethyl-1-(methylthio) -2-butamone O-[(methylamino) -carbonyl] oxine	2
230. Thionazin (Nemafos)	0,0-Diethyl 2-pyrazinyl phosphorothioate	1
231. (Tokuthion) (NTN 8629) Prothiofos	O-2,4-Dichlorophenol-O-ethyl-s-propyl phosphorodithioate	2
232. Toxaphene (Camphechlor)*	A mixture of chlorinated camphene compounds of uncertain identity (combined chlorine 67-69%)	9
233. Triadimefon (Bayleton)	1-(4-Chlorophenoxy)-3,3- -dimethyl-1-(1,2,4-triazol-1-yl) buton-2-one	2
234. Tributyltin benzoate	Tributyltin benzoate	11
235. Tributyltin fluoride	Tributytin fluoride	1
236. Tributyltin oxide	Bis(tri-n-butyltin) oxide	2, 11
237. Trichlorobenzene (TCB)*	1,2,4-Trichlorobenzene	2
238. Trichloronate	O-ethyl O-(2,4,5-trichloro-phenyl)ethylphosphorothioate	2
239. Tricyclazole	5-Methyl-1,2,4-triazolo [3A-b] Benzothiazole	1
240. Trifluralin (Treflan)	a,a,a-Trifluoro-2,6-dinitro- -N,N-Dipropyl-p-toluidine	8
241. (Vancide TH)	Hexahydro-1,3,5-triethyl-s- -triazine	11

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS

(Continued, Page 20 of 23)

Common Name	Chemical Name	Subcategory
242. (Vancide 51Z)	Zinc dimethyldithiocarbamate and Zinc 2-mercaptobenzo-thiazole	11
243. (Vancide 51Z dispersion)	50% Zinc dimethylydithiocarbamate and Zinc 2-mercaptobenzothiazole 50% water	11
244. (Vancide PA)	O-ethyl O-(2,4,5-trichloro-phenyl)ethylphosphorothioate	1
245. Vernolate (Vernam)	S-Propyl N,N-dipropylthio-carbamate	2
246. [ZAC] (zinc ammonium carbonate)	Ammoniates of [ethylenebis (dithiocarbamate)]-zinc	5
247. Zineb	Zinc ethylenebisdithiocarbamate	3, 5
248. Ziram (Vancide MZ-96)	Zinc dimethyldithiocarbamate	3, 11

Under the column titled common name ( ) = trade name

Under the column titled common name [ ] = contractor abbreviation for pesticides that have no common name and an extensive chemical name.

* Pesticide active ingredients which are also priority pollutants.

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS REGULATED BY BPT BUT CURRENTLY NOT MANUFACTURED

(Continued, Page 21 of 23)

Common Name	Chemical Name	Subcategory
249. Aminocarb	4-Dimethylamino-3-methyl-phenyl methyl-carbamate	8
250. BHC (Alpha, Beta, and Delta Isomers)*	1,2,3,4,5,6-Hexachlorocyclohexane, mixed ixomers	9
251. Chlorpropham	Isopropyl-3-chlorophenyl carbamate	9
252. DDD (TDE)*	2,2-Bis(p-chlorophenyl)-1,1-dichloroethane	9
253. DDE (DDX)*	1,1-Dichloro-2,2-Bis(p-chlorophenyl) ethylene	9
254. Demeton-o	o,o-Diethyl o-[2-(ethylthio)ethyl] phosphorothioate	9
255. Demeton-s	o,o-Diethyl s-[2-(ethylthio)ethyl] phosphorothioate	9
256. Dicofol	1,1-Bis(p-chlorophenyl)-2,2,2-trichloroethanol	9
257. Endosulfan*	6,7,8,9,10,10-Hexachloro-1,5,5a, 6,9,9a-Hexahydro-6,9-methano-2,4,3-Benzo[e]-dioxathiepin-3-oxide	8
258. Fenuron	1,1-Dimethyl-3-phenylurea	8
259. Fenuron-TCA	3-Phenyl-1,1-dimethylurea trichloroacetate	9
260. (Lindane) BHC-Gamma*	1,2,3,4,5,6-Hexachlorocyclohexane, gamma isomer	9
261. Methiocarb	4-Methylthio-3,5-xylyl methyl-carbamate	8

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS REGULATED BY BPT BUT CURRENTLY NOT MANUFACTURED

(Continued, Page 22 of 23)

Common Name	Chemical Name	Subcategory
262. Mexacarbate	4-(Dimethylamino)-3,5-xylyl methyl carbamate	8
263. Mirex	Dodecachloro-octahydro-1,3,4-metheno-2h-cyclobuta[c,d]pentalene	8
264. Monuron	3-(p-chlorophenyl)-1,1-dimethylurea	8
265. Monuron-TCA	3-(p-chlorophenyl)-1,1-dimethylurea trichloroacetate	9
266. Neburon	1-n-Butyl-3-(3,4-dichlorophenyl)-1-methylurea	9
267. (Perthane) Ethylan	1,1-Dichloro-2,2-bis(p-ethyl-phenyl) ethane	9
268. Propham (IPC)	Isopropyl carbanilate	8
269. Propoxur	o-Isopropoxyphenyl methylcarbamate	8
270. Swep	Methyl N-(3,4-dichlorophenyl) carbamate	9

Under the column titled common name ( ) = trade name.

* Pesticide active ingredients which are also priority pollutants.

SECTION XXI--APPENDIX 3

LIST OF PESTICIDE ACTIVE INGREDIENTS EXCLUDED FROM BPT REGULATIONS AND CURRENTLY NOT MANUFACTURED

(Continued, Page 23 of 23)

Common Name	Chemical Name	Subcategory
271. Allethrin	2-methyl-4-oxo-3-(2-propenyl)-2-cyclopenten-1-yl 2,2-dimethyl-3-(2-methyl-1-propenyl) cyclopropane carboxylate	2
272. Benzyl benzoate	Benzylbenzenecarboxylate	1
273. Chlorophacinone	2-[(p-chlorophenyl)phenyl--acetyl]-1,3-indandione	2
274. Coumachlor	3-(-acetonyl-4-chlorobenzyl) -4-hydroxycoumarin	1
275. Coumafuryl	4-hydroxy-3-[3-oxo-1-(2-furyl)butyl]coumarin	1
276. Coumatetralyl	4-hydroxy-3-(1,2,3,4-tetra-hydro-1-naphthyl)-coumarin	1
277. 1,8-Naphthalic anhydride	1,8-Naphthalic anhydride	1
278. Quinomethionate	6-methyl-2-oxo-1,3-dithiolo-[4,5b]quinoxaline	2
279. Sulfoxide	1,methyl-2-(3,4-methylene-dioxyphenyl)ethyl octyl sulfoxide	2
280. Warfarin	4-hydroxy-3-(3-oxo-1-phenyl-butyl)coumarin	1

Under the column titled common name ( ) = trade name.

* Pesticide active ingredients which are also priority pollutants.

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

PLANT 1

Analytical Fractions	Method Description
VOLATILES: CHCl3; CCl4; Chlorodibromomethane; Dichlorobromomethane; Trichloroethylene; Tetrachloroethylene; Benzene; Toluene; Ethylbenzene; Chlorobenzene	Liquid/liquid extraction, GC quantitation
PESTICIDES: A1	Acid wash, liquid/liquid extraction, Florisil cleanup, GC quantitation
METALS: 1. Cu, Cr, Pb 2. Hg	HNO3 digestion, AA analysis by: 1. Graphite furnace 2. Cold vapor technique
TRADITIONALS: BOD5, COD, TSS TOC Cyanide	 Standard methods Combustion, IR quantitation Colorimetric
PHENOLS:	Liquid/liquid extraction G.C. quantitation

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

(Continued, Page 2 of 16)

PLANT 2

Analytical Fractions	Method Description
VOLATILES: MeCl2; CHCl3; CCl4; Benzene; Toluene; Trichloroethylene	Liquid/liquid extraction, GC quantitation
PESTICIDES: A1; B1; C1; and D1	Liquid/liquid extraction, methyl esterification (PAAME), GC quantitation
PHENOLS: Phenol, 2-Chlorophenol; 4-Chlorophenol; 2,4-Dichlorophenol; 2,6-Dichlorophenol; 2,4,6-Trichlorophenol	Fritz Chriswell extraction, GC quantitation
TRADITIONALS: BOD5 and 10 day COD TSS	 EPA Method 405.1--Dissolved oxygen potential EPA Method 410.3--Ferrous ammonium sulfate titration EPA Method 160.3--Gravimetric

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

(Continued, Page 3 of 16)

PLANT 3

Analytical Fractions	Method Description
VOLATILES:	
$CHCl_3$; CCl_4; Tetrachloroethylene; Chlorobenzene; Dichlorobenzene	Liquid/liquid extraction, GC quantitation
1,2,4-Trichlorobenzene	Liquid/liquid extraction, GC quantitation
Hexachlorobenzene	Liquid/liquid extraction, GC quantitation GC/MS confirmation
PESTICIDES:	
Al	Liquid/liquid extraction, GC quantitation GC/MS confirmation
PCB's:	Liquid/liquid extraction, GC quantitation
PHENOLS: 2-Nitrophenol; 4-Nitrophenol; PCP	Fritz Chriswell extraction, GC quantitation, GC/MS confirmation
METALS: 1. Be; Cd; Cr; Cu; Ni; 2. Ag; As; Pb; Tl	HNO_3 digestion, AA analysis by: 1. Direct flame 2. Graphite furnace
TRADITIONALS: Cyanide	EPA standard method (colorimetric)

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

(Continued, Page 4 of 16)

PLANT 4

Analytical Fractions	Method Description
VOLATILES:	
$MeCl_2$; $CHCl_3$;	Purge and trap, GC/MS screening,
CCl_4; Trichloroethylene;	Liquid/liquid extraction,
Bromoform; Chlorobenzene	GC quantitation
Benzene; Toluene; Ethylbenzene	GC/MS
PHENOLS:	Fritz Chriswell extraction,
Phenol; 4-Nitrophenol	GC quantitation
PESTICIDES:	Liquid/liquid extraction,
A1; B1; C1; and D1	Florisil cleanup, GC quantitation
METALS:	HNO_3 digestion, standard additions, AA analysis by:
1. Ni; Cr; Cu; Zn; Cd	1. Direct flame
2. Pb; Se; As	2. Graphite furnace
3. Hg	3. Cold vapor technique
TRADITIONALS:	
BOD, 5 and 10 day	Winkler method
COD	Ferrous ammonium sulfate titration
TSS	Evaporation
Cyanide	Colorimetric

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 5

Analytical Fractions	Method Description
VOLATILES: CHCl3; CCl4; Tetrachloroethylene; Benzene; Toluene; Ethylbenzene; Chlorobenzene	Liquid/liquid extraction, GC quantitation
PESTICIDES: A1; B1; C1; D1; E1; F1; G1; and H1	Liquid/liquid extraction, GC quantitation
METALS: 1. Be; Cu; Ni 2. Cr; Pb; Cd	HNO3 digestion, AA analysis by: 1. Direct flame 2. Graphite furnace
TRADITIONALS: BOD; 5 day; COD; TSS TOC Cyanide	 Standard Methods, Federal Register Vol. 41 Combustion, IR quantitation, Colorimetric
PHENOLS: Phenol; 2-Chlorophenol; 2-Nitrophenol; 2,4-Dimethylphenol; 2,4-Dichlorophenol; 2,4,6-trichlorophenol	Liquid/liquid extraction, GC quantitation

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 6

Analytical Fractions	Method Description
VOLATILES:	
Halomethanes; Chlorinated ethanes, ethenes, propane and propene; Aromatics and Chlorobenzene	Purge and trap, GC/MS
1,2-; 1,3-; and 1,4- Dichlorobenzene	Liquid/liquid extraction, Florisil cleanup, GC/MS
PHENOLS:	
Phenol; 2-Chlorophenol; 2,4-Dichlorophenol; 2,4,6-Trichlorophenol; PCP; 2-Nitrophenol; 4-Nitrophenol	Liquid/liquid extraction, Florisil cleanup, GC/MS
PHTHALATES:	
Bis(2-ethylhexyl); Di-n-butyl	Liquid/liquid extraction, Florisil cleanup, GC/MS
PESTICIDES:	
A1; B1; C1; and D1	Liquid/liquid extraction, methyl esterification (PAAME), GC quantitation
E1 and F1	Liquid/liquid extraction, Florisil cleanup, GC/MS
METALS:	HNO_3 digestion, AA analysis by:
1. Zn	1. Direct flame
2. Cd; Cr; Cu; Ni; Pb; As; Sb	2. Graphite furnace
3. Hg	3. Cold vapor technique
TRADITIONALS:	
BOD, 5 and 10 day	Evaporation
TSS	Winkler method

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 7

Analytical Fractions	Method Description
VOLATILES: CHCl3; CCl4; Tetrachloroethylene; Toluene; Hexachloroethane*	Liquid/liquid extraction, GC quantitation, GC/MS confirmation *Did not go to GC/MS
DIENES: Hexachlorobutadiene; Hexachlorocyclopentadiene	Liquid/liquid extraction, GC quantitation
POLYNUCLEAR AROMATICS: Naphthalene; 2-Chloronaphthalene	Liquid/liquid extraction, GC quantitation, GC/MS confirmation
PESTICIDES: A1; B1; C1; and D1	Liquid/liquid extraction, GC quantitation, GC/MS confirmation
METALS: Ni; Cr; Zn; Cu	NA
PHENOLS:	NA
TRADITIONALS: Cyanide	NA

NA = Not Available.

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

(Continued, Page 8 of 16)

PLANT 8

Analytical Fractions	Method Description
PHENOLS: Phenol; 2,4-Dichlorophenol; 2,4,6-Trichlorophenol	Fritz Chriswell extraction, GC quantitation, GC/MS confirmation
PESTICIDES: A1; B1; C1; D1; E1; F1; G1; H1; I1; J1; K1; L1; M1; and N1	Liquid/liquid extraction, Florisil cleanup, GC quantitation
PHTHALATES: All	Liquid/liquid extraction, Florisil cleanup, GC/MS confirmation
METALS: 1. Ni; Zn 2. Cr; Cu; Pb; As 3. Hg	HNO_3 digestion, AA analysis by: 1. Direct flame 2. Graphite furnace 3. Cold vapor technique

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SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 9

Analytical Fractions	Method Description
VOLATILES:	
MeCl2; CHCl3; CCl4; 1,2-Dichloropropane; Benzene; Toluene	Liquid/liquid extraction, GC quantitation
1,2,4-trichlorobenzene	GC/MS, Liquid/liquid extraction
PHENOLS: Phenol; 2,4-dimethylphenol	Liquid/liquid extraction, GC quantitation
PESTICIDES:	
A1	Preconcentration HPLC
B1; C1; and D1	Liquid/liquid extraction, Florisil cleanup, GC (FPD) quantitation
METALS: 1. Sb; Cu 2. Hg	HNO_3 digestion, AA analysis by: 1. Graphite furnace 2. Cold vapor technique
TRADITIONALS:	
BOD, 5 and 10 day	EPA Method 405.1--Dissolved oxygen potentital electrode
COD	EPA Method 410.3--Ferrous ammonium sulfate titration
TSS	EPA Method 160.3--Gravimetric
NH_3	Specific ion electrode
Cyanide	Colorimetric

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 10

Analytical Fractions	Method Description
VOLATILES: $MeCl_2$; $CHCl_3$ 1,2-Dichloroethane; Benzene; Toluene; Ethylbenzene; Chlorobenzene; CCl_4; Trichlorofluoromethane; 1,1-Dichloroethylene; 1,2-Dichloroethylene; Dichlorobromomethane; Trichloroethylene	Liquid/liquid extraction, GC quantitation, GC/MS confirmation
PHENOLS: Phenol; 2-Chlorophenol; 2,4- Dimethylphenol; PCP	Fritz Chriswell extraction, GC quantitation, GC/MS confirmation
NITROSAMINES: Di-n-propyl; dimethyl	Liquid/liquid extraction, GC quantitation, GC/MS confirmation
PHTHALATES: Bis(2-ethylhexyl)	GC quantitation
PESTICIDES: Al	Liquid/liquid extraction, GC quantitation, GC/MS confirmation
METALS: 1. Zn 2. Cr; Cd; Cu; Tl 3. Hg	HNO_3 digestion, AA analysis by: 1. Direct flame 2. Flameless (either Graphite furnace or hydride generator) 3. Cold vapor technique
TRADITIONALS: BOD-5 day; COD; TSS; NH_3, CN^-	NA

NA = Not Available

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 11

Analytical Fractions	Method Description
POLYNUCLEAR AROMATICS: Acenaphthene; Acenaphthylene; Anthracene; Fluorene; Phenanthrene; Pyrene	Liquid/liquid extraction, GC/MS
PHENOLS: 2-Nitrophenol; 2,4-Dichlorophenol	ESE Method 100--Liquid/liquid extraction, GC quantitation
PESTICIDES: A1; B1; and C1	ESE Method 900--Liquid/liquid extraction, Florisil cleanup, GC quantitation
PHTHALATES: Bis(2-ethylhexyl); Butyl benzyl; Di-n-butyl; Dimethyl	ESE Method 900--Liquid/liquid extraction, Florisil cleanup, GC quantitation
PCB's: 1016; 1260; 1248; 1232; 1221; 1254; 1242 (Arochlor)	ESE Method 900--Liquid/liquid extraction, Florisil cleanup, GC quantitation

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 12

Analytical Fractions	Method Description
VOLATILES: $MeCl_2$; $CHCl_3$; CCl_4; Benzene; Toluene	Liquid/liquid extraction, GC quantitation
PHENOLS: Phenol; 2-Chlorophenol; 4-Chlorophenol; 2,4-Dichlorophenol; 2,6-Dichlorophenol; 2,4,6-Trichlorophenol	Fritz Chriswell extraction, GC quantitation
PESTICIDES: A1; B1; and C1	ESE Method 900--Liquid/liquid extraction, Florisil cleanup, GC quantitation
D1; E1; and F1	HPLC preconcentration
PHTHALATES: Bis(2-ethylhexyl); Butyl benzyl; Di-n-butyl	ESE Method 900--Liquid/liquid extraction, Florisil cleanup, GC quantitation
NITROSAMINES: All	Colorimetric
METALS: 1. Sb; As 2. Hg	HNO_3 digestion, AA analysis by: 1. Graphite furnace 2. Cold vapor technique

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 13

Analytical Fractions	Method Description
VOLATILES: $MeCl_2$; $CHCl_3$; CCl_4; 1,1-Dichloroethane; 1,2-Dichloroethane; Trichloroethane; 1,2-Dichloroethylene; Trichloroethylene; Tetrachloroethylene; Bromoform; Benzene; Toluene; Ethylbenzene; Chlorobenzene	Purge and trap, GC/MS screening, Liquid/liquid extraction, GC quantitation
PESTICIDES: A1; B1; C1; D1; E1; and F1	Liquid/liquid extraction, Florisil cleanup, GC quantitation
METALS: 1. Zn; Cu 2. Ni; Cr; Pb; Se 3. Hg	HNO_3 digestion, AA analysis by: 1. Direct flame 2. Graphite furnace 3. Cold vapor technique
TRADITIONALS: BOD, 5 and 10 day COD TSS Cyanide	 Winkler method Ferrous ammonium sulfate titration Evaporation Colorimetric

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 14

Analytical Fractions	Method Description
VOLATILES: $MeCl_2$, $CHCl_3$, Benzene	Liquid/liquid extraction, GC quantitation
PESTICIDES:	
A1 and B1	Liquid/liquid extraction, Florisil cleanup, GC quantitation
C1; D1; E1; and F1	Filtration and preconcentration, HPLC
G1	Digestion and generation of $K^+CH_3OCS_2^-$ (potassium methyl xanthate), spectrophotometric determination
METALS: 1. Zn 2. As, Sb, Cd, Cu, Cr	HNO_3 digestion, AA analysis by: 1. Direct flame 2. Graphite furnace
TRADITIONALS:	
BOD, 5 and 10 day	EPA Method 405.1--Dissolved oxygen potential electrode
TSS	EPA Method 160.3--Gravimetric
COD	EPA Method 410.3--Ferrous ammonium sulfate titration
TOC	Combustion, I.R.
NH_3	Specific ion electrode

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 15

Analytical Fractions	Method Description
VOLATILES: $MeCl_2$; $CHCl_3$; CCl_4; 1,2-Dichloropropane; Benzene; Toluene	Liquid/liquid extraction, GC quantitation
PHENOLS: Phenol; 2-Chlorophenol; 2-Nitrophenol; 2,4-Dichlorophenol; 2,4-Dimethylphenol; 2,4,6-Trichlorophenol; PCP	Liquid/liquid extraction, GC quantitation
PESTICIDES: A1; B1; and C1	HPLC-Direct aqueous injection
METALS: 1. Pb; Cd; Cr	HNO_3 digestion, AA analysis by: 1. Graphite furnace
TRADITIONALS: BOD, 5 and 10 day TOC TSS NH_3	 EPA Method 405.1--Dissolved Oxygen potential electrode Combustion, I.R. EPA Method 160.3--Gravimetric Specific ion electrode

SECTION XXI--APPENDIX 4

SUMMARY OF EPA VERIFICATION CONTRACTOR ANALYTICAL METHODS DEVELOPMENT

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PLANT 16

Analytical Fractions	Method Description
VOLATILES: MeCl2; CHCl3; CCl4; Benzene; Toluene	Liquid/liquid extraction, GC quantitation
PESTICIDES: Al	Liquid/liquid extraction, methyl esterification (PAAME), GC quantitation
PHENOLS: 2-Chlorophenol; 4-Chlorophenol; 2,4-Di- chlorophenol; 2,6-Dichloro- phenol; 2,4,6-Trichlorophenol	Liquid/liquid extraction, GC quantitation
TRADITIONALS:	
BOD, 5 and 10 day	EPA Method 405.1--Dissolved oxygen potential electrode
TSS	EPA Method 160.3--Gravimetric
COD	EPA Method 410.3--Ferrous ammonium sulfate titration
TOC	Combustion, I.R. quantitative

SECTION XXI--APPENDIX 5
308 QUESTIONNAIRE
Pesticide Chemicals Industry

To be returned within 30 days from date of receipt to:

Mr. George Jett
Environmental Protection Agency
Effluent Guidelines Division
Waterside Mall—East Tower (WH552)
401 M Street, S.W.
Washington, D.C. 20460

PART I GENERAL INFORMATION

1. Corporate/Plant Data

   A. Name of Corporation _____

   B. Address of Corporation Headquarters

      Street _____

      City _____ State _____ Zip _____

   C. Name of Plant _____

   D. Address of Plant

      Street _____

      City _____ State _____ Zip _____

   E. Name(s) of personnel to be contacted for information pertaining to this data collection portfolio:

Name	Title	Telephone No.
_____	_____	_____
_____	_____	_____
_____	_____	_____

2. Type of Plant Operations:

   A. Indicate below the type of operation(s) conducted at this facility.

Manufacturer of Pesticide Active Ingredients	____Yes	____No
Formulator/Packager of Pesticides	____Yes	____No
Manufacturer of Pesticides Intermediates	____Yes	____No
Manufacturer of Products Other Than Pesticides	____Yes	____No

   B. If pesticide active ingredients are not manufactured at this facility, complete and return this page only.

Plant_____
City_____State_____

3. Type(s) of Product(s)

A. Indicate below the common name and/or chemical name for each pesticide active ingredient manufactured. For each entry list the total production (1000 lbs) and number of operating days in 1977.

Common Name	Chemical Name	1977 Total Production (1000 lbs)	Operating Days/Year
(Example) Cyanazine	2[(4-Chloro-6-(Ethylamino) s-Triazine-2-yl)Amino]-2-Methylpropionitrile	12,000	180
(Example) Atrazine	2-Chloro-4-(Ethylamine-6 (Isopropylamine)-s-Triazine	6,000	180

B. If products other than pesticides or pesticide intermediates are manufactured, indicate below their industrial classification:

Organic Chemicals ____Yes ____No
Inorganic Chemicals ____Yes ____No
Pharmaceuticals ____Yes ____No
Plastics and Synthetics ____Yes ____No
Other (specify)

_____

_____

Plant_____
City_____State_____

4. Method of Disposal:

A. Indicate below the final disposition and volume disposed (millions of gallons per day, or MGD) for process wastewater from each product listed in 3.A.

NOTE: If the wastewater from a process line is generated with the production of more than one product, please list these products and their associated wastewater on the same line.

Product	Method of Disposal	Volume Disposed (MGD)
(example) Cyanazine	10	0.01

Examples of final disposition:

1 No Process Wastewater Generated
2 Direct Discharge to Navigable Waterway with Treatment
3 Direct Discharge to Navigable Waterway without Treatment
4 To Publicly Owned Treatment Works (POTW) with Pretreatment
5 To Publicly Owned Treatment Works (POTW) without Pretreatment
6 Incineration
7 Deep Well Injection
8 Ocean Discharge
9 Land (Spray Irrigation, etc.)
10 Contract Hauling
11 Total Evaporation
12 Other (Specify)

Plant_____
City_____State_____

B. If National Pollutant Discharge Elimination System (NPDES) or other EPA permits are required for any of the methods of disposal listed above, provide the permit number and effective date. Provide the permit number, name, address, and telephone number for any other process wastewater permit (such as with municipal sewage treatment plants, etc.).

5. Treatment Technology

A. List the treatment units and volume treated (MGD) for process wastewaters generated by each product listed in 3.A. See Example methods of treatment.

Product (s)	Treatment Units	Volume Treated (MGD)
(example) Cyanazine	Mf, Ac, Ne	0.01

Plant_____
City_____State_____

Example Methods of Treatment:

Activated Carbon (Ac)	Resin Adsorption (Ra)
Hydrolysis (Hd)	Chlorination (Ch)
Chemical Oxidation (Co)	Skimming (Sk)
Equalization (Eq)	Ion Exchange (Ie)
Gravity Separation (Gs)	Stripping (Sp)
Aerated Lagoon (Al)	Metal Separation (Ms)
Trickling Filter (Tf)	Neutralization (Ne)
Activated Sludge (As)	Sludge Thickening (St)
Multi-Media Filtration (Mf)	Vacuum Filtration (Vf)
Evaporation Pond (Ep)	Pressure Filtration (Pf)
Multiple-Effect Evaporation (Ev)	Aerobic Digestion (Ad)
	None (No)
Coagulation (Ca)	Other - Specify
Flocculation (Fo)	

B. Provide a simple block diagram of the treatment units listed in 5.A. Indicate the points at which any wastewater from pesticide intermediate or from products other than pesticides may enter the system, and their corresponding volumes (MGD).

C. Are non-contact or cooling wastewaters and process wastewaters combined in the treatment system described above? ____Yes ____No. If so, what is the volume of non-contact wastewater?_____(MGD).

D. Are sanitary and process wastewaters combined in the treatment system described above? ___Yes ___No. If so, what is the volume of sanitary wastewater? _____(MGD).

E. What is the ultimate destination of sludge generated in treatment systems, if applicable?

_____

_____

_____

6. Data Availability:

A. Indicate below if your facility has conducted or has contracted for any of the following as regards its pesticide process wastewaters.

Bench Scale Treatability Studies	____Yes ____No
Pilot Plant Treatability Studies	____Yes ____No
In-Plant Hydraulic/Sampling Surveys	____Yes ____No
Treatment System Modifications	____Yes ____No
Process Modifications	____Yes ____No

Plant_____
City_____State_____

B. Briefly describe the date, scope, and results of any activity indicated in 6.A.

C. Indicate below the existence of any historical wastewater data (such as from studies mentioned above, or from required monitoring). Describe the following: product/process which generated the wastewater; parameters monitored (BOD, COD, pH, Flow, etc.); sample location (refer to treatment system diagram, if necessary); and number of data points available.

Product (s)	Parameters	Sample Location	Number of Data Points
(ex.) Cyanazine, Atrazine	TOC	Before Ac	45
(ex.) Cyanazine, Atrazine	TOC, BOD, TSS	After Ac	150 each

Plant_____
City_____State_____

7. Economic Considerations:

A. Do you have the option of changing your process wastewater disposal from:

(1) City sewer to your own treatment plant?
_____Yes _____No _____Not applicable

(2) Your own treatment plant to the city sewer?
_____Yes _____No _____Not applicable

B. Concerning potential land requirements associated with BAT regulations:

(1) Indicate below the maximum amount of land available for the installation of potential treatment technology:
_____None available _____2.0 acres
_____0.5 acres _____5.0 acres
_____1.0 acres _____greater than 5.0 acres

(2) Indicate below the approximate cost (dollars per acre) for the above mentioned land:
$_____

C. What is the approximate market value of all technical grade pesticide active ingredients manufactured at your plant in 1977?
_____ 0 to 5 million dollars
_____ 5 to 10 million dollars
_____ 10 to 20 million dollars
_____ 25 to 75 million dollars
_____ more than 75 million dollars

Plant_____
City_____ State_____

3. Process Information

A. Provide a general process flow diagram for each pesticide active ingredient manufactured. Please insure each diagram contains the following information:

(1) A block for each step in the process (e.g., precipitation, purification, chlorination, etc.)

(2) Identification of raw materials, reagents, and solvents utilized, with arrows indicating the point of introduction into the process.

(3) Identification of sources of process wastewater with arrows indicating the method of disposal (e.g., to incineration, to municipal sewer, etc.)

(4) Identification of any controls considered to be part of the process (e.g., steam stripping, solvent extraction, etc.) which were not previously categorized as Treatment Technology.

B. If any process modifications or process controls resulting in changes in wastewater characteristics have been installed in the last two years, please complete the following:

		Quantitative Results of Process Modification or Process Control	
		Wastewater Parameter Values	
Product	Description of Process Modification or Process Control	Before	After

Plant_____
City_____State_____

C. If any process modifications or controls are planned but have not yet been installed, please describe below the results of any pilot plant or laboratory studies conducted.

Product	Description of Process Modification or Control	Results of Studies Wastewater Parameter Values		Planned Start-Up Date
		Before	After	

Plant_____
City_____State_____

PART II PRIORITY POLLUTANT INFORMATION

Questions in this part refer to the 129 priority pollutants named on List 1.

1. Identification and quantification of priority pollutants:

A. Check below any compounds on List 1 which have been determined or are suspected to be present as raw materials, intermediates, active ingredients, reaction by-products, or as hydrolysis, oxidation, or degredation products at any point in the pesticide manufacturing or process wastewater treatment system. Also indicate the known/ suspected source of each priority pollutant.

Priority Pollutant	Determined to be Present	Suspected to be Present	Source
(Example) Cyanide	X		Cyanazine Cyanuric Chlorine Unit

Plant_____
City_____ State_____

B. For those pollutants in 1A. that were measured, indicate below the location from which samples were taken, the average flow (MGD); the range of conentrations (mg/l), and the number of data points involved.

Priority Pollutant	Sampling Location	Average Flow (MGD)	Range of Concentrations (mg/l)	Number of Data Points
(example) Cyanide	After As	0.125	0.1-0.5	180

2. Prior pollutant studies/treatment:

A. Describe below any treatment technology installed/modified specifically for the removal of any of the 129 priority pollutants, whether for pesticide or non-pesticide wastewater.

Priority Pollutant	Description of Treatment Unit

Plant_____
City_____State_____

B. Describe below any bench, pilot, or full-scale treatability studies conducted during the last two years for any of the 129 priority pollutants.

Priority Pollutant	Description of Study

C. Describe below any incident removal of priority pollutants via treatment technology not described in 2.A. Indicate influent and effluent concentrations and percent removal.

Priority Pollutant	Treatment Unit

SECTION XXI--APPENDIX 6

VERIFICATION AND SCREENING SAMPLING SUMMARY

Priority Pollutant	Number of Plants in Which Pollutant Detected			
	Verification*		Screening†	
	Raw Waste	Treated Effluent	Raw Waste	Treated Effluent
01 Benzidines				
001 Benzidine	--	--	--	--
002 3,3'-Dichlorobenzidine	--	--	--	--
02 Chlorinated Ethanes and Ethylenes				
003 Chloroethane	1	0	--	--
004 1,1-Dichloroethane	--	--	--	--
005 1,2-Dichloroethane	3	2	2	1
006 1,1-Dichloroethylene	1	1	1	1
007 Hexachloroethane	--	--	1	1
008 1,1,2,2-Tetrachloroethane	2	1	2	2
009 Tetrachloroethylene	1	1	2	3
010 1,2-Trans-dichloroethylene	1	0	1	1
011 1,1,1-Trichloroethane	1	1	--	--
012 1,1,2-Trichloroethane	1	0	--	--
013 Trichloroethylene	4	1	4	1
014 Vinyl chloride	--	--	--	--
03 Cyanides				
015 Cyanide	4	2	9	7
04 Dichloropropane and Dichloropropene				
016 1,2-Dichloropropane	1	0	--	--
017 1,3-Dichloropropene	--	--	--	--
05 Dienes				
018 Hexachlorobutadiene	1	1	0	1
019 Hexachlorocyclopentadiene	1	1	--	--
06 Haloethers				
020 Bis(2-chloroethoxy) methane	--	--	1	1
021 Bis(2-chloroethyl) ether	--	--	--	--
022 Bis(2-chloroisoproyl) ether	--	--	--	--
023 4-Bromophenyl phenyl ether	--	--	--	--
024 2-Chloroethyl vinyl ether	--	--	--	--
025 4-Chlorophenyl phenyl ether	--	--	--	--

SECTION XXI--APPENDIX 6

VERIFICATION AND SCREENING SAMPLING SUMMARY
(Continued, Page 2 of 5)

Priority Pollutant	Number of Plants in Which Pollutant Detected			
	Verification*		Screening†	
	Raw Waste	Treated Effluent	Raw Waste	Treated Effluent
07 Halomethanes				
026 Bromoform	2	0	1	0
027 Carbon tetrachloride	5	4	4	2
028 Chlorodibromomethane	3	1	0	1
029 Chloroform	12	6	8	7
030 Dichlorobromomethane	2	1	1	0
031 Methyl bromide	1	1	1	0
032 Methyl chloride	1	1	--	--
033 Methylene chloride	9	6	6	5
08 Metals				
034 Antimony	--	--	5	6
035 Arsenic	3	2	5	6
036 Beryllium	--	--	7	7
037 Cadmium	1	1	7	7
038 Chromium	11	8	8	8
039 Copper	10	8	8	9
040 Lead	7	3	8	9
041 Mercury	2	0	9	9
042 Nickel	2	1	9	8
043 Selenium	--	--	6	6
044 Silver	--	--	5	6
045 Thallium	1	0	5	7
046 Zinc	1	--	--	--
09 Miscellaneous Priority Pollutants				
047 Acrolein	--	--	--	--
048 Acrylonitrile	--	--	--	--
049 Asbestos	--	--	--	--
050 1,2-Diphenylhydrazine	--	--	1	1
051 Isophorone	--	--	--	--
10 Nitrosamines				
052 N-nitrosodimethylamine	--	--	--	--
053 N-nitrosodiphenylamine	--	--	--	--
054 N-nitrosodi-n-propylamine	1	1	--	--

SECTION XXI--APPENDIX 6

VERIFICATION AND SCREENING SAMPLING SUMMARY
(Continued, Page 3 of 5)

Priority Pollutant	Number of Plants in Which Pollutant Detected			
	Verification*		Screening†	
	Raw Waste	Treated Effluent	Raw Waste	Treated Effluent
11 Nitrosubstituted Aromatics				
055 2,4-Dinitrotoluene	--	--	--	--
056 2,6-Dinitrotoluene	--	--	1	1
057 Nitrobenzene	--	--	--	--
12 Pesticides				
058 Aldrin	1	1	1	0
059 a-BHC-Alpha	--	--	2	0
060 b-BHC-Beta	--	--	1	1
061 r-BHC-Gamma	--	--	1	0
062 g-BHC-Delta	--	--	1	0
063 Chlordane	--	--	1	1
064 Dieldrin	1	1	1	1
065 4,4'-DDD	--	--	1	0
066 4,4'-DDE	--	--	--	--
067 4,4'-DDT	--	--	--	--
068 a-Endosulfan-Alpha	--	--	1	1
069 b-Endosulfan-Beta	--	--	3	1
070 Endosulfan sulfate	--	--	--	--
071 Endrin	1	1	2	1
072 Endrin aldehyde	--	--	1	0
073 Heptachlor	1	1	1	2
074 Heptachlor epoxide	--	--	--	--
075 Toxaphene	1	1	1	0
13 Phenols				
076 2-Chlorophenol	2	1	1	0
077 2,4-Dichlorophenol	3	2	--	--
078 2,4-Dimethylphenol	--	--	--	--
079 4,6-Dinitro-o-cresol	--	--	--	--
080 2,4-Dinitrophenol	--	--	--	--
081 2-Nitrophenol	--	--	2	1
082 4-Nitrophenol	--	--	2	0
083 Parachlorometa cresol	--	--	3	0
084 Pentachlorophenol	1	1	2	0
085 Phenol	7	2	5	4
086 2,4,6-Trichlorophenol	2	3	4	2

SECTION XXI--APPENDIX 6

VERIFICATION AND SCREENING SAMPLING SUMMARY
(Continued, Page 4 of 5)

Priority Pollutant	Number of Plants in Which Pollutant Detected			
	Verification*		Screening†	
	Raw Waste	Treated Effluent	Raw Waste	Treated Effluent
14 Phthalate Esters				
087 Bis(2-ethylhexyl) phthalate	0	1	5	2
088 Butyl benzyl phthalate	--	--	1	1
089 Diethyl phthalate	--	--	--	--
090 Dimethyl phthalate	--	--	1	0
091 Di-n-butyl phthalate	--	--	1	1
092 Di-n-octyl phthalate	--	--	--	--
15 Polychlorinated Biphenyls				
093 PCB-1242	--	--	--	--
094 PCB-1254	--	--	--	--
095 PCB-1221	--	--	--	--
096 PCB-1232	--	--	--	--
097 PCB-1248	--	--	--	--
098 PCB-1260	--	--	--	--
099 PCB-1016	--	--	--	--
16 Polynuclear Aromatic Hydrocarbons				
100 Acenaphthylene	--	--	--	--
101 Acenaphthene	--	--	0	1
102 Anthracene	--	--	1	0
103 Benzo(a)anthracene	--	--	--	--
104 Benzo(a)pyrene	--	--	--	--
105 3,4-Benzofluoranthene	--	--	--	--
106 Benzo(ghi)perylene	--	--	1	1
107 Benzo(k)fluoranthene	--	--	--	--
108 2-Chloronaphthalene	--	--	1	1
109 Chrysene	--	--	--	--
110 Dibenzo(a,h)anthracene	--	--	--	--
111 Fluoranthene	--	--	--	--
112 Fluorene	--	--	--	--
113 Indeno(1,2,3-cd)pyrene	--	--	--	--
114 Naphthalene	2	1	1	1
115 Phenanthrene	--	--	--	--
116 Pyrene	--	--	--	--

SECTION XXI--APPENDIX 6

VERIFICATION AND SCREENING SAMPLING SUMMARY
(Continued, Page 5 of 5)

Priority Pollutant	Number of Plants in Which Pollutant Detected			
	Verification*		Screening†	
	Raw Waste	Treated Effluent	Raw Waste	Treated Effluent
17 TCDD				
117 TCDD (2,3,7,8-Tetrachlorodibenzo-p-dioxin)	--	--	--	--
18 Volatile Aromatics				
118 Benzene	4	1	6	4
119 Chlorobenzene	5	3	2	0
120 1,2-Dichlorobenzene	1	0	--	--
121 1,3-Dichlorobenzene	1	1	--	--
122 1,4-Dichlorobenzene	1	0	--	--
123 Ethylbenzene	4	0	1	1
124 Hexachlorobenzene	--	--	1	1
125 1,2,4-Trichlorobenzene	--	--	--	--
126 Toluene	9	4	3	4

* Total of 16 plants sampled.
† Total of 30 plants sampled.
-- Priority pollutants not detected.

SECTION XXI--APPENDIX 7

THEORETICAL BASIS FOR STEAM STRIPPING DESIGN

Steam stripping offers distinct advantages over other methods for the removal of volatile organics from process effluents. First, the resultant organic stream is often suitable for recovery or incineration. Second, the steam can be directly injected, maximizing the efficiency of energy transfer.

Steam stripping utilizes the greater volatility of the organic with respect to water. A more accurate name for the operation is steam distillation.

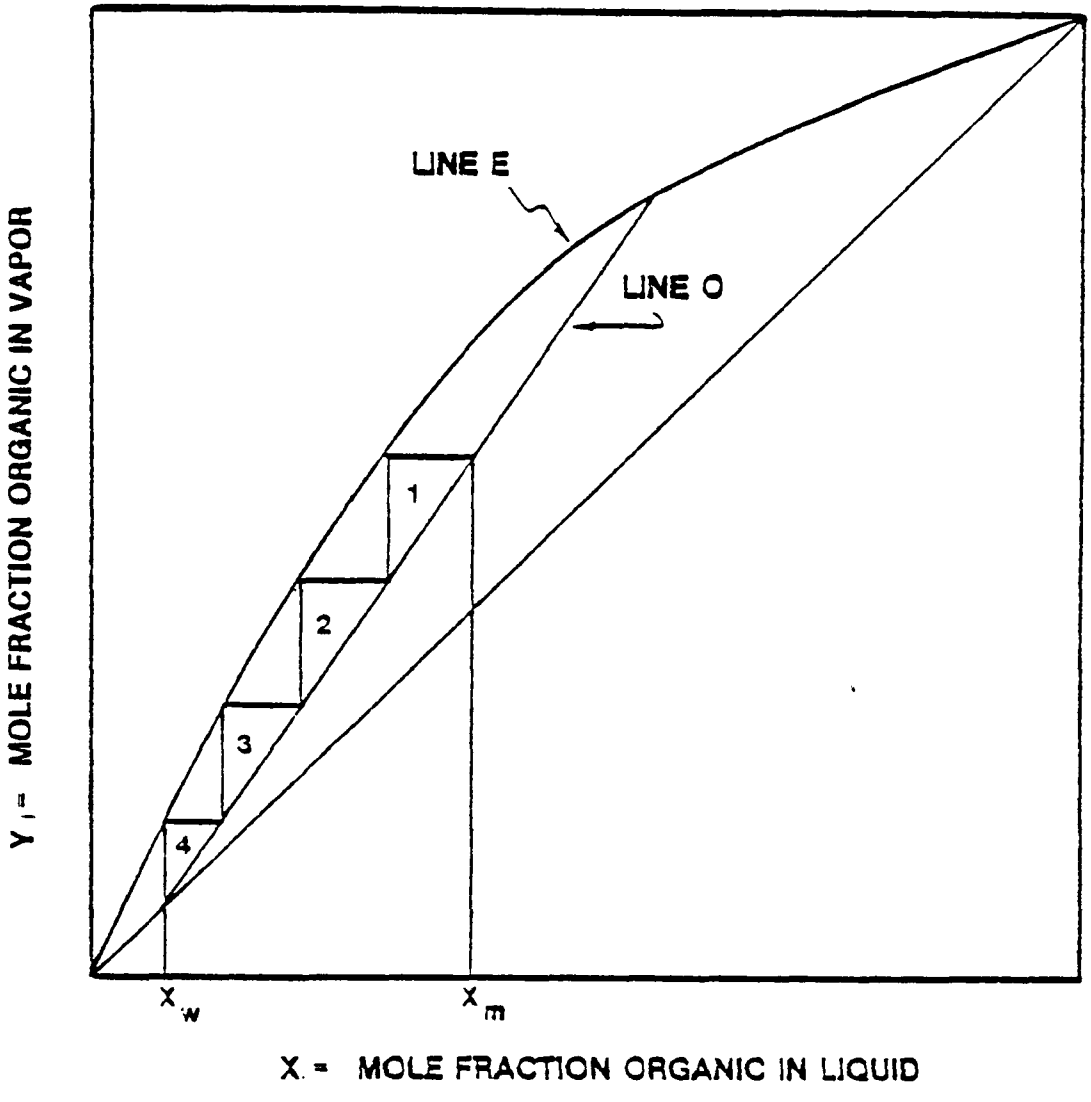
McCABE-THIELE METHOD

The McCabe-Thiele method of analysis has been chosen for designing the stripping column. This method is most suitable for the general type of analysis being employed here. It is reasonably accurate and does not require extensive enthalpy data. It assumes that the vapor and liquid loadings are approximately constant between any point of addition or withdrawal of streams. Since one is dealing with removal of trace organics, large organic concentration changes through the column will have a negligible effect on the vapor and liquid loadings. Therefore, the assumption should be valid. A McCabe-Thiele diagram is shown on the next page.

Line E, the equilibrium line, shows the vapor composition in equilibrium with a particular liquid composition. It is obtained from actual data or is estimated when necessary. Line O, the operating line, shows the actual vapor and liquid compositions occurring in the column. It is defined by material balance. X_m is the feed concentration, and X_w is the effluent concentration. The number of theoretical trays is found by drawing a staircase between the equilibrium and operating lines from X_m through X_w. The number of theoretical trays is the number of steps plus one for the feed tray. The actual number of trays is the number of theoretical trays divided by the tray efficiency. The tray efficiency for this type of operation is usually under 30 percent.

EQUILIBRIUM RELATIONSHIP

The vapor-liquid equilibrium relationship is essential to the analysis of a distillation operation. It is best if the relationship is defined by actual data. However, data are often unavailable. In that case, a good approximation is obtained by utilizing a few simplifications.



McCABE-THIELE DIAGRAM

Generally, it is reasonable to assume that the vapor phase is an ideal gas. The mole fraction of substance in the vapor phase is then defined by:

$$y = P^*/P_T$$

where y = mole fraction in vapor phase,

P^* = partial pressure,

and P_T = total pressure.

Since one is dealing with trace organics, the water will be an ideal solution governed by Raoult's Law. That is:

$$P_w^* = P_w x_w,$$

where P_w = the vapor pressure of water,

and x_w = the mole fraction water in the liquid phase.

This yields:

$$Y_w = P_w x_w / P_T,$$

$$\text{or } Y_w/x_w = P_w/P_T.$$

The organic will be completely non-ideal and governed by Henry's Law. That is:

$$P_o^* = m\, P_T x_o$$

where m = Henry's Law constant.

The Henry's Law constant can be defined at the point of saturation of the organic in water. At this point two liquid phases will be present. The vapor pressure above a two-phase mixture is the sum of the vapor pressures of the two phases. Therefore, the organic phase can be treated independently. In the organic phase, the organic is an ideal solution governed by Raoult's Law. Therefore,

$$P_o^* = P_o(x_o)_o$$

where $(x_o)_o$ = mole fraction organic in the organic phase (this is usually 1, except when water is slightly soluble in the organic),

and $P_o(x_o)_o = m\, P_T(x_o)_{SAT}$,

$$\text{or } m = \frac{P_o(x_o)_o}{P_T(x_o)_{SAT}},$$

where $(x_o)_{SAT}$ = mole fraction organic at saturation.

Resubstituting back into Henry's Law one gets:

$$P_o^* = \frac{P_o(x_o)_o}{P_T(x_o)_{SAT}} \qquad P_T x_o = \frac{P_o(x_o)_o x_o}{(x_o)_{SAT}} = P_o^*$$

This yields:

$$y_o = \frac{P_o(x_o)_o x_o}{(x_o)_{SAT} P_T}$$

$$\text{or} \quad y_o/x_o = \frac{P_o(x_o)_o}{P_T(x_o)_{SAT}}$$

In order to introduce the effect of temperature variation into the analysis, a new term is defined,

$$\alpha = \frac{y_o/x_o}{y_w/x_w}$$

where α = relative volatility.

Substituting one gets:

$$\alpha = \frac{P_o(x_o)_o}{P_T(x_o)_{SAT}} \qquad \frac{P_w}{P_T}$$

$$\text{or } \alpha = \frac{P_o(x_o)_o}{P_w(x_o)_{SAT}}$$

This is calculated at several temperatures in the range over which the distillation will be performed. An average relative volatility is then determined.

The mole fractions of water can be related to the mole fractions of organic. That is:

$$y_w = 1 - y_o$$

$$\text{and } x_w = 1 - x_o$$

Therefore,

$$\alpha = \frac{y_o/x_o}{(1-y_o)/(1-x_o)}$$

This can be algebraically manipulated to yield:

$$y_o = \frac{\alpha\,(x_o)}{1+x_o(\alpha-1)}\ .$$

This equation, incorporating the average relative volatility, is used to estimate the equilibrium line.

SECTION XXI—APPENDIX 8

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Acephate	-	-	-	-	-	-	-	X
Alachlor	-	-	-	-	X	-	-	X
Aldicarb	-	-	-	-	X	-	-	X
Alkylamine hydrochloride	-	-	-	-	-	-	-	X
Ametryne	X	-	X	X	X	-	-	-
Amobam	-	-	X	X	-	-	-	-
Anilazine	-	-	-	-	X	-	-	X
AOP	-	-	X	-	-	-	-	-
Aquatreat DNM 30	-	-	-	-	-	-	-	X
Aspon	-	-	-	-	X	-	-	X
Atrazine	X	-	X	X	X	-	X	-
Azinphos methyl	X	-	X	-	X	-	-	-
Barban	X	-	X	-	-	-	-	-
BBTAC	-	-	-	-	-	-	-	X
Bendiocarb	-	-	-	-	-	-	-	X
Benfluralin	-	-	X	-	X	-	-	-
Benomyl	-	-	X	X	X	X	-	-
Bensulide	-	-	-	-	-	-	-	X
Bentazon	-	-	-	-	X	-	-	X
Benzethonium chloride	-	-	-	-	-	-	-	X
Benzyl bromoacetate	-	-	-	-	-	-	-	X
Bifenox	-	-	-	-	-	-	-	X
Biphenyl	-	-	-	-	-	X	-	X
Bolstar	-	-	X	-	X	-	-	-
Bromacil	-	-	X	-	X	-	-	-
Bromoxynil	-	-	-	-	-	-	-	X

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Bromoxynil octanoate	-	-	-	-	-	-	-	X
Busan 40	-	-	X	X	X	-	-	-
Busan 85	-	-	X	X	X	-	-	-
Busan 90	-	-	-	-	-	-	-	X
Butachlor	-	-	-	-	X	-	-	X
Butylate	-	-	-	-	-	-	-	X
Captafol	-	-	-	-	-	-	-	X
Captan	X	-	X	-	X	-	-	-
Carbam-S	-	-	X	-	-	-	-	-
Carbaryl	X	-	X	-	X	-	X	-
Carbendazim	-	-	X	X	X	X	-	-
Carbofuran	-	-	X	X	X	-	X	-
Carbophenothion	-	-	X	-	-	-	-	-
CDN	-	-	-	-	-	-	-	X
Chloramben	-	-	-	-	-	-	-	X
Chlorobenzilate	-	X°	X	X	X	-	X	-
Chloropicrin	-	-	-	-	-	-	-	X
Chlorothalonil	-	-	-	-	X	-	-	X
Chlorpyrifos	-	-	X	-	X	-	-	-
Chlorpyrifos methyl	-	-	X	-	-	-	-	-
Coumaphos	-	-	X	-	X	-	-	-
Cyanazine	-	-	X	X	X	-	-	-
Cycloate	-	-	-	-	-	-	-	X
Cycloheximide	-	-	-	-	-	-	-	X

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

° - Cited source does not state applicability to these compounds, but direct gas chromatography can be used.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Cycloprate	-	-	-	-	-	-	-	X
Cyhexatin	-	-	-	-	X	X	-	X
Cythioate	-	-	-	-	-	-	-	X
2,4-D	X	-	X	X	X	-	-	-
2,4-D isobutyl ester	X	-	X	X	X	-	-	-
2,4-D isooctyl ester	X	-	X	X	X	-	-	-
2,4-D salt	X	-	X	X	X	-	-	-
Dalapon	-	-	-	-	-	-	-	X
Dazomet	-	-	-	-	-	-	-	X
2,4-DB	-	-	X	X	X	-	-	-
2,4-DB isobutyl ester	-	-	X	X	X	-	-	-
2,4-DB isooctyl ester	-	-	X	X	X	-	-	-
DBCP	-	X°	X	-	-	-	-	-
DCNA	X	-	X	-	X	-	-	-
DCPA	-	-	-	-	X	-	-	X
D-D	-	-	X	-	-	-	-	-
Deet	-	-	X	-	X	-	-	-
Demeton	X	-	X	-	X	-	-	-
Diazinon	X	-	X	X	X	-	-	-
Dicamba	X	-	X	-	-	-	-	-
Dichlofenthion	-	-	-	-	-	-	-	X

* - 304(h) Review Committee = The Monitoring, Reporting, Enforcement, and Funding Program under Section 402 of the 1972 Water Pollution Control Act.

° - Cited source does not state applicability to these compounds, but direct gas chromatography can be used.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Dichlorophen	-	-	-	-	-	-	-	X
Dichlorophen salt	-	-	-	-	-	-	-	X
Dichlorprop	-	-	-	-	-	-	-	X
Dichlorvos	-	-	X	-	X	-	-	-
Dienochlor	-	-	-	-	-	-	-	X
Dimethoxane	-	-	-	-	-	-	-	X
Dinocap	-	-	-	-	X	-	-	X
Dinoseb	-	-	X	X	X	-	X	-
Dioxathion	-	-	-	-	-	X	X	X
Diphacinone	-	-	-	-	-	-	-	X
Diphenamid	-	-	-	-	-	-	-	X
Diphenylamine	-	-	-	-	-	-	-	X
Disulfoton	X	-	X	-	X	-	-	-
Diuron	X	-	X	-	X	X	X	-
Dodine	-	-	-	-	-	X	-	X
Dowicil 75	-	-	-	-	-	-	-	X
Endothall	-	-	-	-	X	-	-	X
EPN	-	-	-	-	-	-	-	X
EPTC	-	-	-	-	-	-	-	X
Ethalfluralin	-	-	X	-	X	-	-	-
Ethion	-	-	-	-	X	-	-	X
Ethoprop	-	-	X	-	X	-	-	-
Ethoxyquin 66%	-	-	-	-	X	-	-	X

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Ethoxyquin 86%	-	-	-	-	X	-	-	X
Ethylene dibromide	-	-	-	-	X	-	-	X
Etridiazole	-	-	X	-	X	-	-	-
EXD	-	-	-	-	-	-	-	X
Famphur	-	-	-	-	X	-	-	X
Fenarimol	-	-	-	-	-	-	-	X
Fenitrothion	-	-	-	-	-	-	-	X
Fensulfothion	-	-	X	-	X	-	-	-
Fenthion	-	-	X	-	X	-	-	-
Fentin hydroxide	-	-	-	-	X	X	-	X
Ferbam	-	-	X	X	X	X	-	-
Fluchloralin	-	-	-	-	X	-	-	X
Fluoridone	-	-	-	-	X	-	-	X
Fluometuron	-	-	X	-	-	-	-	-
Fluoroacetamide	-	-	-	-	-	-	-	X
Folpet	-	-	-	-	-	-	-	X
Fonofos	-	-	-	-	-	-	-	X
Giv-gard	-	-	-	-	-	-	-	X
Glyodin	-	-	-	-	-	-	-	X
Glyphosate	-	-	-	-	X	-	-	X
HAE	-	-	-	-	-	-	-	X
HAMP	-	-	-	-	-	-	-	X
Hexachlorophene	-	-	-	-	-	-	-	X
Hexazinone	-	-	X	-	X	-	-	-

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
HPTMS	-	-	-	-	-	-	-	X
Hyamine 2389	-	-	-	-	-	-	-	X
Hyamine 3500	-	-	-	-	-	-	-	X
Isopropalin	-	-	X	-	X	-	-	-
Kathon 886	-	-	-	-	-	-	-	X
Kinoprene	-	-	-	-	-	-	-	X
KN Methyl	-	-	X	X	X	-	-	-
Lethane 384	-	-	-	-	X	-	X	X
Linuron	X	-	X	-	X	-	X	-
Malathion	X	-	X	-	X	-	X	-
Maleic hydrazide	-	-	-	-	-	-	-	X
Mancozeb	-	-	X	X	X	-	-	-
Maneb	-	-	X	X	X	X	X	-
MCPA	-	-	-	X	X	-	-	X
MCPA isooctyl ester	-	-	-	-	X	-	-	X
MCPP	-	-	-	X	-	-	-	X
Mephosfolan	-	-	-	-	X	-	-	X
Merphos	-	-	X	-	X	-	-	-
Metasol DGH	-	-	-	-	-	-	-	X
Metasol J-26	-	-	-	-	-	-	-	X
Metham	-	-	X	X	X	-	-	-
Methamidophos	-	-	-	-	X	-	-	X
Methomyl	-	-	X	-	X	X	X	-
Methoprene	-	-	-	-	-	-	-	X
Methoxychlor	X	-	X	-	X	-	-	-

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Methylbenzethonium chloride	-	-	-	-	-	-	-	X
Methylene bisthiocyanate	-	-	-	-	-	-	-	X
Metribuzin	-	-	X	-	-	-	-	-
Mevinphos	-	-	X	-	X	-	-	-
MGK 264	-	-	-	-	-	-	-	X
MGK 326	-	-	-	-	-	-	-	X
Molinate	-	-	-	-	-	-	-	X
Monocrotophos	-	-	-	-	-	-	-	X
Nabam	-	-	X	X	X	-	-	-
Nabonate	-	-	-	-	-	-	-	X
Naled	-	-	X	-	X	-	-	-
Napropamide	-	-	-	-	-	-	-	X
Naptalam	-	-	-	-	-	-	-	X
Niacide	-	-	X	X	X	-	-	-
Nitrofen	-	-	-	-	-	-	-	X
NMI	-	-	-	-	-	-	-	X
Norflurazon	-	-	-	-	X	-	-	X
Octhilinone	-	-	-	-	-	-	-	X
Oryzalin	-	-	-	-	X	-	X	X
Oxamyl	-	-	X	-	X	-	-	-
Oxydemeton	-	-	-	-	X	-	-	X
Oxyfluorfen	-	-	-	-	-	-	-	X
Paraquat	-	-	-	-	-	-	-	X
Parathion ethyl	X	-	X	-	X	-	-	-

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Parathion methyl	X	-	X	-	X	-	-	-
PBED	-	-	-	-	-	-	-	X
PCNB	X	X°	X	X	X	-	-	-
PCP salt	-	X	-	X	X	-	-	-
Pebulate	-	-	-	-	-	-	-	X
Permethrin	-	-	-	-	-	-	-	X
Phenylphenol	-	-	-	X	-	-	-	X
Phenylphenol sodium salt	-	-	-	X	-	-	-	X
Phorate	-	-	X	-	X	-	-	-
Phosfolan	-	-	-	-	-	-	-	X
Phosmet	-	-	-	-	-	-	-	X
Picloram	-	-	-	-	-	X	-	X
Pindone	-	-	-	-	-	-	-	X
Piperalin	-	-	-	-	-	-	-	X
Piperonyl butoxide	-	-	-	-	-	X	-	X
Polyphase antimildew	-	-	-	-	-	-	-	X
Profluralin	-	-	X	X	X	-	-	-
Prometon	X	-	X	-	X	-	-	-
Prometryn	X	-	X	X	X	-	-	-
Pronamide	-	-	-	-	-	-	-	X
Propachlor	-	-	X	-	X	-	-	-
Propanil	-	-	-	-	-	-	-	X
Propargite	-	-	-	-	-	-	-	X

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

° - Cited source does not state applicability to these compounds, but direct gas chromatography can be used.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Propazine	X	-	X	X	X	-	-	-
Propionic acid	-	-	-	-	-	-	-	X
Pyrethrins	-	-	-	-	-	-	-	X
8 Quinolinol citrate	-	-	-	-	-	-	-	X
8 Quinolinol sulfate	-	-	-	-	-	-	X	X
Resmethrin	-	-	-	-	-	-	-	X
RH 787	-	-	-	-	-	-	-	X
Ronnel	-	-	X	-	X	-	-	-
Rotenone	-	-	-	-	-	-	-	X
Siduron	-	-	X	-	-	-	-	-
Silvex	X	-	X	-	X	-	-	-
Silvex isooctyl ester	X	-	X	-	X	-	-	-
Silvex salt	X	-	X	-	X	-	-	-
Simazine	X	-	X	X	X	-	-	-
Simetryne	-	-	X	-	X	-	-	-
Sodium monofluoroacetate	-	-	-	-	-	-	-	X
Stirofos	-	-	X	-	X	-	-	-
Sulfallate	-	-	-	-	-	-	-	X
2,4,5-T	X	-	X	-	X	-	-	-
TCMTB	-	-	-	-	-	-	-	X
Tebuthiuron	-	-	-	-	X	-	-	X
Temephos	-	-	-	-	-	-	-	X
Terbacil	-	-	X	-	X	X	-	-
Terbufos	-	-	-	-	X	-	-	X
Terbuthylazine	X	-	X	-	-	-	-	-

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Terbutryn	-	-	X	X	-	-	-	-
Thiabendazole	-	-	-	-	-	-	-	X
Thiofanox	-	-	-	-	-	-	-	X
Thionazin	-	-	-	-	-	-	-	X
Tokuthion	-	-	X	-	X	-	-	-
Triadimefon	-	-	X	-	X	-	-	-
Tributyltin benzoate	-	-	-	-	X	X	-	X
Tributyltin fluoride	-	-	-	-	X	X	-	X
Tributyltin oxide	-	-	-	-	X	X	-	X
Trichloronate	-	-	X	-	X	-	-	-
Tricyclazole	-	-	X	-	X	-	-	-
Trifluralin	X	-	X	X	X	-	-	-
Vancide PA	-	-	-	-	-	-	-	X
Vancide TH	-	-	-	-	-	-	-	X
Vancide 51Z	-	-	-	-	-	-	-	X
Vancide 51Z dispersion	-	-	-	-	-	-	-	X
Vernolate	-	-	-	-	-	-	-	X
ZAC	-	-	X	-	X	-	-	-
Zineb	-	-	X	X	X	X	-	-
Ziram	-	-	X	X	X	X	-	-

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Pesticides Previously Regulated But Currently Not Manufactured								
Aminocarb	X	-	X	-	-	-	-	-
Chlorpropham	X	-	X	-	-	-	-	-
Demeton-o	X	-	X	-	-	-	-	-
Demeton-s	X	-	X	-	-	-	-	-
Dicofol	X	-	X	-	X	-	-	-
Fenuron	X	-	X	-	-	-	-	-
Fenuron-TCA	X	-	X	-	-	-	-	-
Methiocarb	X	-	X	-	-	-	-	-
Mexacarbate	X	-	X	-	-	-	-	-
Mirex	X	-	X	-	-	-	-	-
Monuron	X	-	X	-	-	X	-	-
Monuron-TCA	X	-	X	-	-	-	-	-
Neburon	X	-	X	-	-	-	-	-
Perthane	X	-	X	-	-	-	-	-
Propham	X	-	X	-	-	-	-	-
Propoxur	X	-	X	-	X	-	-	-
Swep	X	-	X	-	-	-	-	-

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

SECTION XXI—APPENDIX 8

(Continued, Page 12 of 12)

PESTICIDE ANALYTICAL METHOD AVAILABILITY/STATUS

Pesticide	EPA Promulgated	EPA Proposed	Under Current EPA Review: Method In 304(h) Review Committee*	Under Current EPA Review: Verification Contractor	Under Current EPA Review: Industry	Under Current EPA Review: Literature	Other Method	Future EPA
Pesticides Excluded from BPT and Currently Not Manufactured								
Allethrin	-	-	-	-	-	-	-	-
Benzyl benzoate	-	-	-	-	-	-	-	-
Chlorophacinone	-	-	-	-	-	-	-	-
Coumachlor	-	-	-	-	-	-	-	-
Coumafuryl	-	-	-	-	-	-	-	-
Coumatetralyl	-	-	-	-	-	-	-	-
1,8-Naphthalic anhydride	-	-	-	-	-	-	-	-
Quinomethionate	-	-	-	-	-	-	-	-
Sulfoxide	-	-	-	-	X	-	-	-
Warfarin	-	-	-	-	-	-	-	-
Total Number of Pesticides	59	4	129	45	121	20	14	140

* - 304(h) Review Committee = The analytical methods review authorized by Section 304(h) of the 1972 Federal Water Pollution Control Act.

SECTION XXI--APPENDIX 9

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Acephate	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Metals	Zinc
	Volatile Aromatics	Benzene
		Toluene
Alachlor	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Volatile Aromatics	Benzene
		Chlorobenzene
		Toluene
Aldicarb		None
Alkylamine hydrochloride		None
Allethrin	Volatile Aromatics	Benzene
		Toluene
Ametryne	Cyanides	Cyanide
	Volatile Aromatics	Benzene
		Toluene
Aminocarb	Phenols	Phenol
Amobam		None
Anilazine	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Cyanides	Cyanide
	Volatile Aromatics	Chlorobenzene

SECTION XXI--APPENDIX 9

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 2 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
AOP*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
Aquatreat DNM 30	Metals	Zinc
Aspon	Volatile Aromatics	Benzene Toluene
Atrazine	Cyanides	Cyanide*
	Halomethanes	Carbon tetrachloride* Chloroform* Methyl chloride* Methylene chloride*
	Volatile Aromatics	Benzene* Toluene*
* Subcategory 10 only.		
Azinphos methyl	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane Tetrachloroethylene
Barban		None
BBTAC		None
Bendiocarb		None
Benfluralin*	Nitrosamines	N-nitrosodi-n-propylamine
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
Benomyl		None
Bensulide	Volatile Aromatics	Benzene Toluene

SECTION XXI--APPENDIX 9

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 3 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Bentazon	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Volatile Aromatics	Chlorobenzene
Benzethonium chloride	Volatile Aromatics	Benzene
		Toluene
Benzyl benzoate		None
Benzyl bromoacetate	Volatile Aromatics	Benzene
		Toluene
BHC	Pesticides	a-BHC-alpha
		b-BHC-beta
		r-BHC-delta
		Lindane (g-BHC-gamma)
	Volatile Aromatics	Benzene
		Toluene
Bifenox	Halomethanes	Chloroform
		Methyl chloride
		Methylene chloride
	Phenols	2,4-Dichlorophenol
Biphenyl		None
Bolstar	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Phenols	2,4-Dichlorophenol
		Phenol
Bromacil	Halomethanes	Carbon tetrachloride
		Chloroform
		Methylene chloride
Bromoxynil	Volatile Aromatics	Benzene
		Toluene

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 4 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Bromoxynil octanoate	Volatile Aromatics	Benzene Toluene
Busan 40		None
Busan 85		None
Busan 90	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
	Phenols	Phenol
Butachlor	Volatile Aromatics	Benzene Toluene
Butylate	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Captafol		None
Captan*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
Carbam-S		None
Carbaryl	Volatile Aromatics	Benzene Toluene
Carbendazim*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		

SECTION XXI--APPENDIX 9

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 5 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Carbofuran		None
Carbophenothion	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
	Volatile Aromatics	Benzene Toluene
CDN	Volatile Aromatics	Benzene Chlorobenzene Toluene
Chloramben*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
Chlordane	Dienes Pesticides	Hexachlorocyclopentadiene Heptachlor
Chlorobenzene	Phenols	2,4-Dichlorophenol Pentachlorophenol Phenol
	Volatile Aromatics	Benzene Chlorobenzene Toluene
Chlorobenzilate	Volatile Aromatics	Benzene Toluene
Chlorophacinone	Volatile Aromatics	Benzene Chlorobenzene Toluene
	Halomethanes	Methyl bromide
Chloropicrin		None

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 6 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Chlorothalonil	Chlorinated Ethanes and Ethylenes Cyanides Halomethanes	1,2-Dichloroethane Tetrachloroethylene Cyanide Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Chlorpropham	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane Tetrachloroethylene
Chlorpyrifos	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Chlorpyrifos methyl	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Coumachlor		None
Coumafuryl		None
Coumaphos		None
Coumatetralyl		None
Cyanazine*	Cyanides	Cyanide
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
Cycloate	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Cycloheximide	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Cycloprate	Volatile Aromatics	Benzene Toluene
Cyhexatin	Volatile Aromatics	Benzene Toluene
Cythioate	Volatile Aromatics	Benzene Toluene
2,4-D	Phenols	2,4-Dichlorophenol Phenol
	Volatile Aromatics	Benzene Chlorobenzene Toluene
2,4-D isobutyl ester*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
2,4-D isooctyl ester*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
2,4-D salt		None
Dalapon		None
Dazomet		None

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
2,4-DB	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
	Phenols	2,4-Dichlorophenol Phenol
2,4-DB isobutyl ester*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
2,4-DB isooctyl ester*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
DBCP		None
DCNA*		None
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
DCPA	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
	Volatile Aromatics	Benzene Chlorobenzene Toluene
D-D		None
DDD	Volatile Aromatics	Benzene Chlorobenzene
DDE	Volatile Aromatics	Benzene Chlorobenzene

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
DDT	Volatile Aromatics	Benzene Chlorobenzene Toluene
Deet	Volatile Aromatics	Benzene Toluene
Demeton	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
	Volatile Aromatics	Benzene Toluene
Demeton-o	Volatile Aromatics	Benzene Toluene
Demeton-s	Volatile Aromatics	Benzene Toluene
Diazinon	Volatile Aromatics	Benzene Toluene
Dicamba	Halomethanes	Chloroform Methyl chloride Methylene chloride
	Phenols	2,4-Dichlorophenol Pentachlorophenol Phenol
	Volatile Aromatics	Benzene Chlorobenzene Toluene
Dichlofenthion*	Phenols	2,4-Dichlorophenol Pentachlorophenol

* Pesticide wastewater to be regulated for volatile compound as yet to be designated.

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Dichlorobenzene, ortho	Volatile Aromatics	Benzene Chlorobenzene 1,2-Dichlorobenzene Toluene
Dichlorobenzene, para	Volatile Aromatics	Benzene Chlorobenzene 1,4-Dichlorobenzene Toluene
Dichloroethyl ether		None
Dichlorophen*	Phenols	Phenol
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
Dichlorophen salt		None
Dichloropropene	Dichloropropane and Dichloropropene	1,3-Dichloropropene
Dichlorprop*		None
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
Dichlorvos		None
Dicofol	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
Dienochlor	Dienes Metals Volatile Aromatics	Hexachlorocyclopentadiene Copper Benzene Toluene
Dimethoxane		None
Dinocap	Phenols	2,4-Dinitrophenol Phenol

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 11 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Dinoseb		None
Dioxathion		None
Diphacinone		None
Diphenamid	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
	Volatile Aromatics	Benzene
		Chlorobenzene
Diphenylamine*		None
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
Disulfoton	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Volatile Aromatics	Benzene
		Toluene
Diuron	Volatile Aromatics	Benzene
		Chlorobenzene
		Toluene
Dodine	Cyanides	Cyanide
Dowicil 75		None
Endosulfan	Dienes	Hexachlorocyclopentadiene
	Pesticides	a-Endosulfan-alpha
		b-Endosulfan-beta
Endothall		None
Endrin	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Dienes	Hexachlorocyclopentadiene
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Pesticides	Endrin

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 12 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
EPN	Nitrosamines	N-nitrosodi-n-propylamine
	Phenols	4-Nitrophenol
		Phenol
	Volatile Aromatics	Benzene
		Chlorobenzene
		Toluene
EPTC	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
Ethalfluralin*	Nitrosamines	N-nitrosodi-n-propylamine
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
Ethion	Halomethanes	Methyl bromide
	Volatile Aromatics	Benzene
		Toluene
Ethoprop		None
Ethoxyquin 66%	Volatile Aromatics	Toluene
Ethoxyquin 86%	Volatile Aromatics	Toluene
Ethylene dibromide		None
Etridazole	Volatile Aromatics	Benzene
EXD		None
Famphur	Volatile Aromatics	Benzene
		Toluene
Fenarimol		None
Fenitrothion	Cyanides	Cyanide
	Metals	Copper
	Volatile Aromatics	Benzene
		Toluene

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Fensulfothion	Metals	Copper
	Volatile Aromatics	Benzene
		Toluene
Fenthion	Halomethanes	Carbon tetrachloride
		Chloroform
		Methylene chloride
	Phenols	Phenol
Fentin hydroxide	Volatile Aromatics	Benzene
		Chlorobenzene
		Toluene
Fenuron		None
Fenuron-TCA	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
Ferbam		None
Fluchloralin*	Nitrosamines	N-nitrosodi-n-propylamine
Fluoridone	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Volatile Aromatics	Benzene
		Toluene
Fluometuron*	Cyanides	Cyanide
Fluoroacetamide		None
Folpet		None

* Pesticide wastewater to be regulated for volatile compound as yet to be designated.

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 14 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Fonofos	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Volatile Aromatics	Benzene
		Toluene
Giv-gard	Nitrosamines	N-nitrosodi-n-propylamine
	Volatile Aromatics	Benzene
		Toluene
Glyodin		None
Glyphosate	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
HAE		None
HAMP		None
Heptachlor	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Dienes	Hexachlorocyclopentadiene
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Pesticides	Heptachlor
Hexachlorophene	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
	Phenols	Pentachlorophenol
Hexazinone	Volatile Aromatics	Benzene
		Toluene
HPTMS		None
Hyamine 2389	Volatile Aromatics	Benzene
		Toluene

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Hyamine 3500	Volatile Aromatics	Toluene
Isopropalin	Nitrosamines	N-nitrosodi-n-propylamine
Kathon 886	Volatile Aromatics	Benzene Toluene
Kinoprene*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
KN methyl		None
Lethane 384	Cyanides Volatile Aromatics	Cyanide Benzene Toluene
Lindane	Pesticides Volatile Aromatics	a-BHC-Alpha b-BHC-Beta r-BHC-delta Lindane (g-BHC-gamma) Benzene Toluene
Linuron	Volatile Aromatics	Benzene Chlorobenzene
Malathion		None
Maleic hydrazide		None
Mancozeb	Metals	Zinc
Maneb	Metals	Zinc
MCPA	Phenols Volatile Aromatics	2,4-Dichlorophenol Phenol Benzene Toluene

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
MCPA isooctyl ester*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
MCPP	Phenols	2,4-Dichlorophenol Phenol
	Volatile Aromatics	Benzene Toluene
Mephosfolan	Volatile Aromatics	Benzene Toluene
Merphos		None
Metasol DGH	Cyanides	Cyanide
Metasol J-26		None
Metham		None
Methamidophos	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
Methiocarb	Phenols	Phenol
Methomyl	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Methoprene		None
Methoxychlor	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
	Phenols	Phenol
Methylbenzethonium chloride	Volatile Aromatics	Benzene Toluene

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Methyl bromide	Halomethanes	Methyl bromide
Methylene bisthiocyanate	Cyanides	Cyanide
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
Metribuzin	Cyanides	Cyanide
	Halomethanes	Methyl bromide
Mevinphos		None
Mexacarbate	Phenols	Phenol
MGK 264	Volatile Aromatics	Benzene
		Toluene
MGK 326	Volatile Aromatics	Benzene
		Toluene
Mirex	Dienes	Hexachlorocyclopentadiene
Molinate	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
Monocrotophos	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Metals	Copper
Monuron		None
Monuron-TCA	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
	Volatile Aromatics	Benzene
		Toluene

PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
(Continued, Page 18 of 26)

Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Nabam*		None
Nabonate	Cyanides	Cyanide
Naled	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
1,8-Napthalic anhydride		None
Napropamide	Volatile Aromatics	Benzene Toluene
Naptalam	Volatile Aromatics	Benzene Toluene
Neburon	Volatile Aromatics	Benzene Toluene
Niacide		None
Nitrofen	Phenols	2,4-Dichlorophenol 4-Nitrophenol Pentachlorophenol Phenol
	Volatile Aromatics	Benzene Chlorobenzene Toluene
NMI	Volatile Aromatics	Benzene Toluene
Norflurazon		None
Octhilinone		None
Oryzalin	Nitrosamines	N-nitrosodi-n-propylamine

* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Oxamyl		None
Oxydemeton	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Oxyfluorfen	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane Tetrachloroethylene
Paraquat	Halomethanes	Chloroform Methyl chloride Methylene chloride
Parathion ethyl	Phenols	4-Nitrophenol
Parathion methyl	Phenols	2,4-Dinitrophenol 4-Nitrophenol
PBED	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
PCNB	Volatile Aromatics	Benzene Chlorobenzene Toluene
PCP	Phenols	2,4-Dichlorophenol Pentachlorophenol Phenol
	Volatile Aromatics	Chlorobenzene
PCP salt		None
Pebulate	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
	Metals	Zinc
Permethrin		None

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Perthane	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
	Volatile Aromatics	Benzene
		Chlorobenzene
		Toluene
Phenylphenol	Phenols	2,4-Dichlorophenol
		Phenol
	Volatile Aromatics	Benzene
		Chlorobenzene
Phenylphenol sodium salt	Phenols	2,4-Dichlorophenol
		Phenol
	Volatile Aromatics	Benzene
		Chlorobenzene
Phorate		None
Phosfolan	Volatile Aromatics	Benzene
		Toluene
Phosmet	Volatile Aromatics	Benzene
		Toluene
Picloram	Cyanides	Cyanide
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
Pindone	Volatile Aromatics	Benzene
		Toluene
Piperalin	Volatile Aromatics	Benzene
		Chlorobenzene
		Toluene
Piperonyl butoxide		None
Polyphase antimildew		None

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Profluralin	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Nitrosamines	N-nitrosodi-n-propylamine
Prometon	Cyanides	Cyanide
	Volatile Aromatics	Benzene
		Toluene
Prometryn	Cyanides	Cyanide
	Volatile Aromatics	Benzene
		Toluene
Pronamide	Volatile Aromatics	Benzene
		Toluene
Propachlor	Volatile Aromatics	Benzene
		Toluene
Propanil	Volatile Aromatics	Benzene
		Toluene
Propargite		None
Propazine	Cyanides	Cyanide
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Volatile Aromatics	Benzene
		Toluene
Propham		None
Propionic acid		None
Propoxur	Phenols	Phenol
Pyrethrins		None

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
8 Quinolinol citrate		None
8 Quinolinol sulfate		None
Qinomethionate	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Resmethrin	Cyanides Volatile Aromatics	Cyanide Benzene Toluene
RH-787*		None
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
Ronnel*	Phenols	2,4-Dichlorophenol
* Pesticide wastewater to be regulated for volatile compound as yet to be designated.		
Rotenone	Volatile Aromatics	Benzene Toluene
Siduron	Volatile Aromatics	Chlorobenzene
Silvex	Phenols Volatile Aromatics	2,4-Dichlorophenol Phenol Benzene Toluene
Silvex isooctyl ester		None
Silvex salt		None

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Simazine	Cyanides	Cyanide
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Volatile Aromatics	Benzene
		Toluene
Simetryne	Cyanides	Cyanide
	Volatile Aromatics	Benzene
		Toluene
Sodium monofluoroacetate		None
Stirofos	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
		Tetrachloroethylene
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Volatile Aromatics	Chlorobenzene
Sulfallate		None
Sulfoxide	Volatile Aromatics	Benzene
		Toluene
SWEP	Volatile Aromatics	Benzene
		Toluene
2,4,5-T	Phenols	Phenol
		2,4-Dichlorophenol
	Volatile Aromatics	Benzene
		Toluene
TCMTB	Cyanides	Cyanide
	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Metals	Copper

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Tebuthiuron		None
Temephos	Chlorinated Ethanes and Ethylenes	1,2-Dichloroethane
Terbacil		None
Terbufos		None
Terbuthylazine	Cyanides	Cyanide
	Volatile Aromatics	Benzene
		Toluene
Terbutryn	Cyanides	Cyanide
	Volatile Aromatics	Benzene
		Toluene
Thiabendazole	Cyanides	Cyanide
	Volatile Aromatics	Benzene
Thiofanox*		None
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
Thionazin		None
Tokuthion	Phenols	2,4-Dichlorophenol
	Volatile Aromatics	Benzene
		Toluene
Toxaphene	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Pesticides	Toxaphene
	Volatile Aromatics	Benzene
		Chlorobenzene
		Toluene

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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Pesticide	Priority Pollutant Group	Priority Pollutant to be Regulated
Triadimefon	Halomethanes	Carbon tetrachloride
		Chloroform
		Methyl chloride
		Methylene chloride
	Phenols	2,4-Dichlorophenol
		Pentachlorophenol
	Volatile Aromatics	Benzene
		Toluene
Tributyltin benzoate		None
Tributyltin fluoride		None
Tributyltin oxide	Volatile Aromatics	Benzene*
		Toluene*
* Subcategory 2 only.		
Trichlorobenzene	Pesticides	a-BHC-alpha
		b-BHC-beta
		r-BHC-delta
		Lindane (g-BHC-gamma)
	Volatile Aromatics	Benzene
		Chlorobenzene
		1,2,4-Trichlorobenzene
		Toluene
Trichloronate	Phenols	2,4-Dichlorophenol
		Phenol
	Volatile Aromatics	Benzene
		Toluene
Tricyclazole		None
Trifluralin	Nitrosamines	N-nitrosodi-n-propylamine
Vancide TH		None
Vancide 51Z		None
Vancide 51Z dispersion		None

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PRIORITY POLLUTANTS TO BE REGULATED IN PESTICIDE WASTEWATERS
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esticide	Priority Pollutant Group	Priority Pollutant to be Regulated
'ancide PA		None
'ernolate	Halomethanes	Carbon tetrachloride Chloroform Methyl chloride Methylene chloride
Warfarin		None
ZAC*	Metals	Zinc
* Presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
Zineb†	Metals	Zinc
† For Subcategory 5 only, presence of nonconventional pollutant ammonia determined that this pesticide be placed in a subcategory with volatile compounds which require similar treatment (stripping).		
Ziram	Metals	Zinc**
** Subcategory 3 only.		