821R92004

Cost-Effectiveness Analysis of Proposed Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry

Dr. Lynne G. Tudor, Economist
Economic and Statistical Analysis Branch

Engineering and Analysis Division
Office of Science and Technology
U.S. Environmental Protection Agency
Washington, DC 20460

ACKNOWLEDGEMENTS

The most credit must be given to Dr. Thomas E. Fielding for his knowledge, experience, cooperation, and leadership as project officer. Credit must also be given to Dr. Richard Healy and Ryan Childs of SASD, and to the whole pesticide team for their professional manner, conscientious effort, and contributions.

Credit must be given to Abt Associates for their assistance and support in performing the underlying analysis supporting the conclusions detailed in this report. Their study was performed under Contracts 68-C0-0080 and 68-03-3548. Particular thanks are given to Randi Currier and Robert Sartain.

TABLE OF CONTENTS

		Page
Section 1	Introduction	1.1
Section 2	Methodology	2.1
Section 3	Findings	3.1
Section 4	Comparison of Values	4.1
Appendix A	Regulated Pesticide Active Ingredients	A.1
Appendix B	Facilities Excluded from Analysis	B.1
Appendix C	Sensitivity Analysis of POTW Removals	C.1

SECTION 1: INTRODUCTION

This analysis is submitted in support of the proposed effluent limitations guidelines and standards for the Pesticide Chemical Manufacturers Industry. The report analyzes the cost-effectiveness of two alternative regulatory options: a Treated Discharge Option and a Zero Discharge Option[1]. This report compares the total annualized cost incurred for each of the two regulatory options to the corresponding effectiveness of that option in reducing the discharge of pollutants. The effectiveness measure used is pounds of pollutant removed weighted by an estimate of the relative toxicity of the pollutant. The rationale for this measure, referred to as "pound equivalents (PE) removed," is described later in this report.

Section 2 of the report discusses the cost-effectiveness methodology employed in this report including the pollutants included in the analysis and the toxic weighting factors. Section 3 presents the findings of the analysis. In Section 4, the cost-effectiveness values are compared to cost-effectiveness values for other promulgated rules. Three appendices are also included. Appendix A lists the pesticide active ingredients (PAIs) proposed for regulation. Appendix B provides details regarding pesticide manufacturing facilities which are excluded from the cost-effectiveness analysis. Finally, Appendix C provides a sensitivity analysis of POTW removal efficiencies.

[1]Detailed information on each option can be found in *Technical Development Document for Proposed Effluent Limitations Guidelines, New Source Performance Standards and Pretreatment Standards for the Pesticide Chemicals Point Source Category* (hereafter the Technical Development Document).

SECTION 2: METHODOLOGY

Cost-effectiveness calculations are used in the effluent limitations guideline setting process to compare the efficiency of one regulatory option in removing pollutants to another regulatory option. Cost-effectiveness is defined as the incremental (to another option or to a benchmark, such as existing treatment) annual cost of a pollution control option in an industry or industry subcategory per incremental pollutant removal (measured in copper-based pound-equivalents). In other words, the cost-effectiveness value represents the unit cost of removing the next pound-equivalent of pollutant. While not required by the Clean Water Act, the cost-effectiveness analysis is a useful tool for evaluating regulatory options for the removal of toxic pollutants.[2] It is not intended to analyze the removal of conventional pollutants (oil and grease, biological oxygen demand and total suspended solids), thus the removal of conventional pollutants is not addressed in this report.

A cost-effectiveness calculation is simply a ratio of the annualized cost of a regulatory control option for a group of dischargers to the pollutant loadings removed from surface waters by that option for that particular group of dischargers.[3] Three factors are of particular importance in the cost-effectiveness calculations. First, the analysis is based on removals of "pound-equivalents" -- a term used to describe a pound of pollutant weighted for its toxicity.[4] Use of pound-equivalents reflects the fact that some pollutants are more toxic than others and permits removals to be summed across pollutants. Second, where there are a number of control options being evaluated, the analysis is often done on an incremental basis -- using the incremental cost and removals of one control option compared to another control option or to existing treatment.[5] Third, cost-effectiveness values are considered high or low only within a given context, such as similar discharge status or compared to effluent limitations guidelines for other industries.

---

[2] Cost-effectiveness analysis is applied to Best Available Technology Economically Achievable and Pretreatment Standard for Existing Sources options which control toxic pollutants.

[3] For control technologies that remove pollutants that would otherwise be volatilized prior to dilution in the receiving stream, the cost-effectiveness analysis includes removals of volatile pollutants as well as removals from the aqueous wastestream.

[4] Copper is used as the standard pollutant for developing toxic weighting factors because it is a toxic metal and is commonly both released and removed from industrial effluent.

[5] Incremental cost-effectiveness can be calculated from current treatment or from another control option.

There are a number of steps in a cost-effectiveness analysis which may be summarized as follows:

- Determine the relevant wastewater pollutants;
- Estimate relative toxic weights of priority and other pollutants;
- Define pollution control approaches;
- Calculate pollutant removals for each control option;
- Determine annualized cost for each control option;
- Calculate cost-effectiveness values (and adjust to 1981 year dollars); and
- Compare cost-effectiveness values.

These steps are discussed below.

1. Pollutant Discharges Considered in a Cost-Effectiveness Analysis

Under the pesticide manufacturer effluent limitations guidelines, the regulated pollutants include 28 priority pollutants and 122 individual pesticide active ingredients (PAIs). Some of the factors considered in selecting pollutants for regulation include toxicity, frequency of occurrence, and amount of pollutant in the wastestream. A list of regulated pollutants is shown in Appendix A. Not all regulated pollutants, however, are included in the cost-effectiveness analysis since loadings are not calculated for some regulated pollutants. Table 1 lists the PAIs and priority pollutants that are included in the cost-effectiveness analysis.

2. Relative Toxic Weights of Priority and Other Pollutants

Cost-effectiveness analyses account for differences in toxicity among the regulated pollutants by using toxic weighting factors (TWF). These factors are necessary because different pollutants have different potential effects on human and aquatic life. For example, a pound of nickel (TWF=0.036) in an effluent stream has a significantly lesser potential effect than a pound of cadmium (TWF=5.12). The toxic weighting factors are used to calculate the (copper-based) "pound equivalent" unit -- a standard measure of toxicity.

In the majority of cases, toxic weighting factors are derived from both chronic freshwater aquatic criteria (or toxic effect levels) and human health criteria (or toxic effect levels) established for the consumption of fish[6]. These factors are then standardized by relating them to copper.[7] The resulting toxic weighting factors for each PAI

---

[6]A complete discussion of the development of the toxic weighting factors can be found in *Toxic Weighting Factors for Pesticide Active Ingredients and Priority Pollutants* Draft Final Report, March 18, 1992, located in the Administrative Record.

[7]While the water quality criterion for copper has been revised (to 12.0 ug/l), the cost-effectiveness analysis uses the old criterion (5.6 ug/l) to facilitate comparisons with cost-effectiveness values for other effluent limitations guidelines. The revised higher criteria for copper results in a toxic weighting factor for copper not equal to 1.0 but equal to 0.467.

TABLE 1
Active Ingredients and Priority Pollutants Included
in Cost-Effectiveness Analysis

Pollutant Number	CAS Number	Pollutant Name	AI/PP
A016	94757	2,4-D	AI
A052	30560192	Acephate	AI
A053	50594664	Acifluorfen	AI
A054	15972608	Alachlor	AI
A055	116063	Aldicarb	AI
A058	834128	Ametryn	AI
A060	1912249	Atrazine	AI
A178	1861401	Benfluralin	AI
A062	17804352	Benomyl	AI
A197	35400432	Bolstar	AI
A068	314409	Bromacil	AI
A069	1689845	Bromoxynil	AI
A259	533744	Dazomet	AI
A219	51026289	Busan 40	AI
A218	128030	Busan 85	AI
A021	2491385	Busan 90	AI
A070	23184669	Butachlor	AI
A073	2425061	Captafol	AI
A241	128041	Carbam-S	AI
A075	63252	Carbaryl	AI
A076	1563662	Carbofuran	AI
A080	2675776	Chloroneb	AI
A081	76062	Chloropicrin	AI
A082	1897456	Chlorothalonil	AI
A086	2921882	Chlorpyrifos	AI
A025	21725462	Cyanazine	AI
A017	94826	DB, 2,4- salts and esters	AI
A110	1861321	DCPA	AI
A171	134623	Deet	AI
A236	78488	DEF	AI
A103	333415	Diazinon	AI
A005	542756	Dichloropropene, 1,3-	AI
A030	120365	Dichlorprop	AI
A012	62737	Dichlorvos	AI
A113	78342	Dioxathion	AI
A183	298044	Disulfoton	AI
A007	4080313	Dowicil 75	AI
A123	145733	Endothall	AI
A125	55283686	Ethalfluralin	AI
A126	563122	Ethion	AI
A127	13194484	Ethoprophos	AI
A132	60168889	Fenarimol	AI
A182	115902	Fensulfothion	AI
A133	55389	Fenthion	AI
A135	2164172	Fluometuron	AI
A071	7166190	Giv-gard	AI

TABLE 1 (continued)
Active Ingredients and Priority Pollutants Included
in Cost-Effectiveness Analysis

Pollutant Number	CAS Number	Pollutant Name	AI/PP
A138	1071836	Glyphosate	AI
A036	34375285	HAE	AI
A140	76448	Heptachlor	AI
A142	51235042	Hexazinone	AI
A056	68424851	Hyamine 3500	AI
A144	33820530	Isopropalin	AI
A220	137417	KN Methyl	AI
A150	121755	Malathion	AI
A027	94746	MCPA	AI
A120	13590971	Metasol DGH	AI
A221	53404629	Metasol J26	AI
A154	10265926	Methamidophos	AI
A156	16752775	Methomyl	AI
A158	72435	Methoxychlor	AI
A045	21087649	Metribuzin	AI
A022	7786347	Mevinphos	AI
A177	113484	MGK 264	AI
A117	136458	MGK 326	AI
A172	142596	Nabam	AI
A118	138932	Nabonate	AI
A163	6317186	Nalco D-2303	AI
A175	27314132	Norflurazon	AI
A028	26530201	Octhilinone	AI
A190	.	Organo-copper compounds	AI
A191	.	Organo-mercury compounds	AI
A192	.	Organo-tin compounds	AI
A196	42874033	Oxyfluorofen	AI
A204	40487421	Pendimethalin	AI
A208	52645532	Permethrin	AI
A210	92842	Phenothiazine	AI
A211	90437	Phenylphenol	AI
A212	298022	Phorate	AI
A215	1918021	Picloram	AI
A216	51036	Piperonyl butoxide	AI
A042	55406536	Polyphase	AI
A223	1610180	Prometon	AI
A224	7287196	Prometryn	AI
A039	23950585	Pronamide	AI
A026	1918167	Propachlor	AI
A041	709988	Propanil	AI
A227	79094	Propanoic acid	AI
A226	139402	Propazine	AI
A275	8003347	Pyrethrins	AI
A239	122349	Simazine	AI
A035	21564170	TCMTB	AI
A252	34014181	Tebuthiuron	AI

TABLE 1 (continued)
Active Ingredients and Priority Pollutants Included
in Cost-Effectiveness Analysis

Pollutant Number	CAS Number	Pollutant Name	AI/PP
A254	5902512	Terbacil	AI
A255	13071799	Terbufos	AI
A256	5915413	Terbuthylazine	AI
A257	886500	Terbutryn	AI
A032	148798	Thiabendazole	AI
A008	43121433	Triadimefon	AI
A264	1582098	Trifluralin	AI
A243	137428	Vapam	AI
P001	83329	Acenaphthene	PP
P078	120127	Anthracene	PP
P115	25541544	Arsenic (III)	PP
P004	71432	Benzene	PP
P066	117817	Bis(2-ethylhexyl) phthalate	PP
P048	75274	Bromodichloromethane	PP
P046	74839	Bromomethane	PP
P007	108907	Chlorobenzene	PP
P016	75003	Chloroethane	PP
P045	74873	Chloromethane	PP
P024	95578	Chlorophenol, 2-	PP
P119	18540299	Chromium (VI)	PP
P120	7440508	Copper	PP
P121	57125	Cyanide	PP
P051	124481	Dibromochloromethane	PP
P025	95501	Dichlorobenzene, 1,2-	PP
P027	106467	Dichlorobenzene, 1,4-	PP
P013	75343	Dichloroethane, 1,1-	PP
P010	107062	Dichloroethane, 1,2-	PP
P029	75354	Dichloroethene, 1,1-	PP
P030	156605	Dichloroethene, trans-1,2-	PP
P044	75092	Dichloromethane	PP
P031	120832	Dichlorophenol, 2,4-	PP
P032	78875	Dichloropropane, 1,2-	PP
P034	105679	Dimethylphenol, 2,4-	PP
P059	51285	Dinitrophenol, 2,4-	PP
P038	100414	Ethylbenzene	PP
P039	206440	Fluoranthene	PP
P080	86737	Fluorene	PP
P053	77474	Hexachlorocyclopentadiene	PP
P012	67721	Hexachloroethane	PP
P122	7439921	Lead	PP
P123	7439976	Mercury	PP
P055	91203	Naphthalene	PP
P124	7440020	Nickel	PP
P081	85018	Phenanthrene	PP
P065	108952	Phenol	PP
P084	129000	Pyrene	PP

TABLE 1 (continued)
Active Ingredients and Priority Pollutants Included
in Cost-Effectiveness Analysis

Pollutant Number	CAS Number	Pollutant Name	AI/PP
P015	79345	Tetrachloroethane, 1,1,2,2-	PP
P085	127184	Tetrachloroethene	PP
P006	56235	Tetrachloromethane	PP
P086	108883	Toluene	PP
P047	75252	Tribromomethane	PP
P011	71556	Trichloroethane, 1,1,1-	PP
P087	79016	Trichloroethene	PP
P023	67663	Trichloromethane	PP
P021	88062	Trichlorophenol, 2,4,6-	PP
P128	7440666	Zinc	PP

TABLE 2 TOXIC WEIGHTING FACTORS FOR PESTICIDE ACTIVE INGREDIENTS (PAIs)
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD PAI No.	CAS No.	Pollutant Name	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	TOXIC WEIGHTING FACTORS (TWFs) Chronic	Human	Total
A052	30560191	Acephate	320	1,200	0.018	0.005	0.022
A053	50594664	Acifluorfen \ Blazer	850		0.0066	–	0.0066
A054	15972608	Alachlor \ Lasso	10	682	0.560	0.0082	0.568
A055	116063	Aldicarb \ Temik	2.5	1,080	2.24	0.0052	2.25
A057	584792	Allethrin	0.021		267	–	267
A058	834128	Ametryn	32	855	0.175	0.0065	0.182
A048	2032599	Aminocarb \ Matacil	0.60		9.33	–	9.3
A059	33089612	Amitraz	13	45	0.431	0.124	0.555
A096	3566107	Amobam	891		0.0063	–	0.0063
A018	101053	Anilazine \ Dyrene	0.0027	7,700	2,074	0.0007	2,074
A188	637036	Arsenobenzene			–	–	ND
A180	3244904	Aspon	3.5		1.60	–	1.60
A060	1912249	Atrazine	60	730	0.093	0.0077	0.101
A186	86500	Azinphos methyl \ Guthion, methyl–	0.01	200	560	0.028	560
A033	22936750	Belclene 310	30		0.187	–	0.187
A061	22781233	Bendiocarb \ Ficam	23.5	7,200	0.238	0.0008	0.239
A178	1861401	Benfluralin \ Benefin	3.7	570	1.51	0.0098	1.52
A062	17804352	Benomyl \ Benlate	0.30	13,100	18.7	0.0004	18.7
A251	741582	Bensulide \ Betesan	7		0.800	–	0.800
A240	25057890	Bentazon	193,700	2600	2.89E−05	0.0022	2.18E−03
A105	121540	Benzethonium chloride	14		0.40	–	0.40
A064	120514	Benzyl benzoate	233		0.024	–	0.024
A147	58899	BHC, gamma– \ Lindane	0.08	0.625	70.0	9.0	79
A063	608731	BHC, technical–	1	0.460	5.6	12.2	17.8
A066	42576023	Bifenox	23.5		0.238	–	0.238
A088	380286	Bioquin	12		0.467		0.467 (a)
A067	92524	Biphenyl	15	1,235	0.3733	0.0045	0.378
A197	35400432	Bolstar \ Sulprofos	52		0.108	–	0.108
A068	314409	Bromacil	1,000		0.0056	–	0.0056
A160	74839	Bromomethane	550	57.0 *	0.010	0.098	0.108
A069	1689845	Bromoxynil	0.5	1,320	11.2	0.0042	11.2
A259	533744	Busamid \ Dazomet \ Mylone	295		0.019	–	0.019
A219	51026289	Busan 40	1.4		4.00	–	4.0 (b)
A035	21564170	Busan 72	6		0.933	–	0.933
A217	31512740	Busan 77 \ PBED	10		0.560	–	0.560
A218	128030	Busan 85	3		1.87	–	1.87
A021	2491385	Busan 90	42.2		0.133	–	0.133
A070	23184669	Butachlor	2.6		2.15	–	2.15
A130	2008415	Butylate	10.5	32,600	0.533	0.0002	0.534
A073	2425061	Captafol \ Difolatan	1	8,000	5.60	0.0007	5.6
A074	133062	Captan	1.7	3,800	3.29	0.0015	3.30
A241	128041	Carbam–S	34		0.165	–	0.165
A075	63252	Carbaryl \ Sevin	0.02	4,000	280	0.0014	280
A076	1563662	Carbofuran \ Furadan	2.4	4,500	2.33	0.0012	2.33
A077	55285148	Carbosulfan	0.15	110	37.3	0.051	37.4
A078	133904	Chloramben	500	6,200	0.011	0.0009	0.012
A079	57749	Chlordane	0.0043	0.0059	1,302	949	2,251
A024	470906	Chlorfenvinphos \ Supona	10.95	580	0.511	0.0097	0.521

Source: Toxic Weighting Factors for Pesticide Active Ingredients and Priority Pollutants, U.S. EPA, March 18, 1992.

TABLE 2 TOXIC WEIGHTING FACTORS FOR PESTICIDE ACTIVE INGREDIENTS (PAIs)
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD PAI No.	CAS No.	Pollutant Name	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	TOXIC WEIGHTING FACTORS (TWFs) Chronic	Human	Total
A129	510156	Chlorobenzilate	7	103	0.800	0.054	0.854
A080	2675776	Chloroneb	1,200		0.0047	–	0.0047
A037	3691358	Chlorophacinone	150		0.037	–	0.04
A046	122883	Chlorophenoxyacetic acid, 4– (CPA)	6,250		0.001	–	0.001
A081	76062	Chloropicrin	0.95		5.89	–	5.9
A082	1897456	Chlorothalonil	0.076	850	73.68	0.0066	73.69
A083	1982474	Chloroxuron	4.3		1.30	–	1.30
A272	101213	Chlorpropham	324	100,000	0.017	5.60E−05	0.017
A085	5598130	Chlorpyrifos methyl	1	98	5.60	0.057	5.7
A086	2921882	Chlorpyrifos \ Dursban	0.041	11.8	137	0.475	137
A089	14951918	Copper EDTA	12		0.467	–	0.467 (a)
A043	117522	Coumafuryl	0.34	25	16.5	0.224	16.7 (c)
A181	56724	Coumaphos	0.001		5,600	–	5,600
A109	7700176	Crotoxyphos \ Ciodrin	0.55		10.2	–	10.2
A025	21725462	Cyanazine	100	2,900	0.056	0.0019	0.058
A245	1134232	Cycloate	45		0.124	–	0.124
A091	66819	Cycloheximide	70		0.080	–	0.080
A141	54460467	Cycloprate \ Zardex	0.432		13.0	–	13.0
A106	60515	Cygon \ Dimethoate	2.2	27	2.55	0.207	2.75
A092	75990	Dalapon	550	103,000	0.010	5.44E−05	0.010
A017	94826	DB, 2,4– salts and esters	20	740	0.280	0.0076	0.288
A110	1861321	DCPA \ Dacthal	62	11,200	0.090	0.0005	0.091
A171	134623	Deet	3,750		0.0015	–	0.0015
A236	78488	DEF	0.27	0.1	20.7	56.0	76.7
A094	8065483	Demeton \ Systox	0.1	0.95	56.0	5.89	61.9
A187	301122	Demeton−O−methyl	0.4	16,000	14.0	0.0004	14.0
A095	13684565	Desmedipham \ Betanex	6		0.933	–	0.933
A103	333415	Diazinon \ Spectracide	0.009	630	622	0.0089	622
A097	96128	Dibromo−3−chloropropane, 1,2–	810		0.0069	–	0.0069
A098	1918009	Dicamba	195	23,100	0.029	0.0002	0.029
A099	117806	Dichlone \ Phygon	0.14		40.0	–	40.0
A011	97234	Dichlorophen	36		0.156	–	0.156
A016	94757	Dichlorophenoxyacetic acid, 2,4–	80	1,960	0.0700	0.0029	0.073
A005	542756	Dichloropropene, 1,3–	4.5	87 *	1.24	0.064	1.31
A030	120365	Dichlorprop	2,340		0.0024	–	0.0024
A012	62737	Dichlorvos	0.001	12	5,600	0.467	5,600
A020	99309	Dicloran \ Botran	147	7,300	0.038	0.0008	0.039
A001	115322	Dicofol \ Kelthane	0.53	0.0098	10.6	571.429	582.0
A108	141662	Dicrotophos \ Bidrin	21.5	1,080	0.26	0.01	0.27
A093	2227170	Dienochlor \ Pentac	0.002		3,294	–	3,294
A104	35367385	Diflubenzuron	0.16	940	35.0	0.0060	35.0
A044	534521	Dinitro−o−cresol, 4,6–	3.3	765	1.70	0.0073	1.70
A019	39300453	Dinocap \ Karathane	0.15		37.3	–	37.3
A112	88857	Dinoseb \ DNBP	0.32	30	17.5	0.187	17.7
A113	78342	Dioxathion	0.09	150	62.2	0.037	62.3
A114	82666	Diphacinone	105		0.053	–	0.053
A115	957517	Diphenamid	1,600	108,000	0.0035	5.19E−05	0.0036
A116	122394	Diphenylamine	378	1,000	0.015	0.0056	0.020

TABLE 2 TOXIC WEIGHTING FACTORS FOR PESTICIDE ACTIVE INGREDIENTS (PAIs)
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD PAI No.	CAS No.	Pollutant Name	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	TOXIC WEIGHTING FACTORS (TWFs) Chronic	Human	Total
A183	298044	Disulfoton	0.05	0.9	112	6.22	118
A119	330541	Diuron \ DCMU	1.6	150	3.50	0.037	3.54
A121	2439103	Dodecylguanidine monoacetate	100	740	0.056	0.0076	0.064
A007	4080313	Dowicil 75	420		0.013	–	0.013
A122	115297	Endosulfan mixed isomers	0.056	2	100	2.800	103
A123	145733	Endothall	7	431,000	0.800	1.30E−05	0.800
A124	72208	Endrin	0.0023	0.81	2,435	6.91	2,442
A199	2104645	EPN \ Santox	0.0056	0.009	1,000	622	1,622
A246	759944	EPTC	575	12,600	0.0097	0.0004	0.010
A125	55283686	Ethalfluralin	0.08		70.0	–	70.0
A126	563122	Ethion \ Bladan	0.02	3.6	280	1.556	282
A127	13194484	Ethoprophos	11.5	15	0.487	0.4	0.860
A050	91532	Ethoxyquin	212		0.026	–	0.026
A003	106934	Ethylene dibromide	608	0.13	0.0092	43.1	43.1
A049	2593159	Etridiazole	12.1		0.463	–	0.463
A102	502556	EXD			–	–	ND
A131	52857	Famphur \ Famophos	48.5		0.12	–	0.12
A014	85347	Fenac \ Chlorfenac	55		0.102	–	0.102
A128	22224926	Fenamiphos	5.5	180	1.02	0.031	1.05
A132	60168889	Fenarimol \ Rubigan	9.1		0.615	–	0.615
A184	122145	Fenitrothion	0.00015	330	37,333	0.017	37,333
A182	115902	Fensulfothion \ Desanit	0.5	81	11.2	0.069	11.3
A133	55389	Fenthion \ Baytex	0.006	4.7	933	1.19	935
A090	51630581	Fenvalerate \ Pydrin	0.036	680	156	0.0082	156
A134	14484641	Ferbam	4.5	830,000	1.24	6.75E−06	1.24
A135	2164172	Fluometuron	30	3,400	0.187	0.0016	0.188
A136	640197	Fluoroacetamide, 2−	2,000		0.0028	–	0.0028
A137	133073	Folpet	0.39	50	14.4	0.11	14.5
A200	944229	Fonofos	0.07	144	80.0	0.039	80.0
A071	7166190	Giv−gard	0.2		28.0	–	28.0
A138	1071836	Glyphosate \ Roundup	65	34,700	0.086	0.0002	0.086
A139	1333240	Glyphosine			–	–	ND
A036	34375285	HAE	4.27E+07		1.31E−07	–	1.31E−07
A140	76448	Heptachlor	0.0038	0.0021	1,474	2,667	4,140
A009	70304	Hexachlorophene	1.5	0.009	3.73	622	626
A142	51235042	Hexazinone	5,000	3,540,000	0.0011	1.58E−06	0.0011
A250	29803574	HPTMS	486		0.012	–	0.012
A162	1399800	Hyamine 2389	60		0.093	–	0.093
A056	68424851	Hyamine 3500	60		0.093	–	0.093 (d)
A072	75605	Hydroxydimethylarsine oxide		65	–	0.086	0.086
A143	25311711	Isofenphos	400	72	0.014	0.078	0.092
A144	33820530	Isopropalin	1	273	5.60	0.021	5.6
A146	4849325	Karbutilate	3,750		0.0015	–	0.0015
A220	137417	KN Methyl	1.4		4.00	–	4.00 (b)
A038	2686999	Landrin I	50		0.112	–	0.112
A013	2655154	Landrin II	50		0.112	–	0.112
A065	112561	Lethane 384	160		0.04	–	0.04
A148	330552	Linuron	90	300	0.062	0.019	0.081

TABLE 2 TOXIC WEIGHTING FACTORS FOR PESTICIDE ACTIVE INGREDIENTS (PAIs) (CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD PAI No.	CAS No.	Pollutant Name	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	TOXIC WEIGHTING FACTORS (TWFs) Chronic	Human	Total
A149	569642	Malachite green	0.305		18.4	–	18.4
A150	121755	Malathion	0.100	2,700	56	0.0021	56
A002	123331	Maleic hydrazide	6,250	54,000,000	0.0009	1.04E−07	0.0009
A087	8018017	Mancozeb	23	89,700	0.243	6.24E−05	0.244
A151	12427382	Maneb \ Vancide	17	54,000,000	0.329	1.04E−07	0.329
A027	94746	MCPA	60	380	0.093	0.015	0.108
A047	94815	MCPB	3.5	1,770	1.60	0.0032	1.60
A031	93652	MCPP \ Mecoprop	445	8,970	0.013	0.0006	0.013
A153	53780340	Mefluidide	5,000		0.0011	–	0.0011
A263	150505	Merphos \ Folex	13	0.22	0.431	25.5	25.9
A120	13590971	Metasol DGH	100	740	0.056	0.0076	0.064 (e)
A221	53404629	Metasol J26	60		0.093	–	0.093 (d)
A243	137428	Metham sodium \ Vapam	1.4		4.00	–	4.00
A154	10265926	Methamidophos	2,300	5,980	0.0024	0.0009	0.0034
A155	950378	Methiadathion \ Supracide	0.11	234	50.9	0.024	50.9
A040	2032657	Methiocarb	0.25	120	22.4	0.0467	22.4
A156	16752775	Methomyl \ Lannate	0.05	269,000	112	2.08E−05	112
A157	40596698	Methoprene	15.5	1,300	0.361	0.0043	0.366
A158	72435	Methoxychlor	0.03	6.5	187	0.862	188
A159	15716026	Methyl benzethonium chloride	14		0.40	–	0.40 (f)
A161	124583	Methylarsonic acid	40,500		0.0001	–	0.0001
A167	9006422	Metiram	64		0.088	–	0.088
A165	51218452	Metolachlor	100	23,400	0.056	0.0002	0.06
A045	21087649	Metribuzin	2,100	135,000	0.0027	4.15E−05	0.0027
A022	7786347	Mevinphos \ Phosdrin	0.002	212,000	2,800	2.64E−05	2,800
A166	315184	Mexacarbate \ Mexcarbole \ Zectran	0.5		11.2	–	11.2
A177	113484	MGK 264	130		0.043	–	0.043
A117	136458	MGK 326	666		0.0084	–	0.0084
A247	2212671	Molinate	10.5	360	0.533	0.016	0.549
A169	150685	Monuron	4,455		0.0013	–	0.0013
A168	140410	Monuron TCA	5,000		0.0011	–	0.0011
A172	142596	Nabam	9.8		0.571	–	0.571
A118	138932	Nabonate	1.4		4.00	–	4.0 (b)
A163	6317186	Nalco D−2303	3.5		1.60	–	1.60
A173	300765	Naled \ Dibrom	0.004	3,100	1,400	0.0018	1,400
A170	15299997	Napropamide	400	21,500	0.014	0.0003	0.014
A176	132661	Naptalam	3,800		0.0015	–	0.0015
A152	15339363	Niacide	4.5	820,000	1.24	6.83E−06	1.24 (g)
A174	18530568	Norea \ Noruron	70		0.080	–	0.080
A175	27314132	Norflurazon	10,000		0.0006	–	0.0006
A028	26530201	Octhilinone			–	–	ND
A273		Organo−antimony compounds	30	4,300	0.187	0.0013	0.188 (h)
A189		Organo−cadmium compounds	1.1	170	5.09	0.0329	5.12 (h)
A190		Organo−copper compounds	12		0.467	–	0.467 (h)
A191		Organo−mercury compounds	0.012	0.146	466.7	38	505 (h)
A192		Organo−tin compounds	0.017	3.2E−04	329.4	17,500	17,829 (i)
A194	19044883	Oryzalin	9.5	9,100	0.589	0.0006	0.590
A195	23135220	Oxamyl \ Vydate	24	138,000	0.233	4.06E−05	0.233

TABLE 2 TOXIC WEIGHTING FACTORS FOR PESTICIDE ACTIVE INGREDIENTS (PAIs)
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD PAI No.	CAS No.	Pollutant Name	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	TOXIC WEIGHTING FACTORS (TWFs) Chronic	Human	Total
A196	42874033	Oxyfluorofen	124	18	0.045	0.311	0.356
A203	56382	Parathion ethyl	0.013	125	431	0.045	431
A107	298000	Parathion methyl	0.007	39	800	0.144	800
A248	1114712	Pebulate \ Tillam	370		0.015	–	0.015
A204	40487421	Pendimethalin \ Prowl	4.20	372	1.33	0.015	1.35
A205	82688	Pentachloronitrobenzene \ Quintozene	6.60	27	0.8	0.211	1.1
A206	87865	Pentachlorophenol	13	29,000	0.431	0.0002	0.431
A207	37924132	Perfluidone	15,600		0.0004	–	0.0004
A208	52645532	Permethrin \ Ambush \ Pounce	0.023	4,300	243.5	0.0013	243.5
A101	72560	Perthane \ Ethylan	0.04		140	–	140
A209	13684634	Phenmedipham \ Bentanal	165		0.034	–	0.034
A210	92842	Phenothiazine	198		0.028	–	0.028
A006	58366	Phenoxarsine, 10,10'−oxydi−	0.018		311	–	311
A211	90437	Phenylphenol, o−	59.9	798	0.093	0.0070	0.101
A212	298022	Phorate \ Famophos \ Thimet	0.006	3.40	933	1.65	935
A213	2310170	Phosalone \ Azofone	1	76	5.60	0.074	5.7
A185	732116	Phosmet \ Imidan	0.1	2,600	56.0	0.0022	56.0
A214	13171216	Phosphamidon \ Dimecron	0.14	2,700	40.0	0.0021	40.0
A215	1918021	Picloram	1.35	1,400,000	4.15	4.00E−06	4.15
A029	83261	Pindone	8,630		0.0006	–	0.0006
A216	51036	Piperonyl butoxide	18.0	120	0.31	0.05	0.36
A244	120627	Piperonyl sulfoxide	17.7		0.316	–	0.316
A042	55406536	Polyphase \ Guardsan 388	7,030		0.0008	–	0.0008
A228	25606411	Previcur N \ Propamocarb HCL	11,750	720,000	0.0005	7.78E−06	0.0005
A222	41198087	Profenofos \ Curacron	0.008		700	–	700
A223	1610180	Prometon \ Pramitol	86	150	0.065	0.037	0.102
A224	7287196	Prometyrn \ Caparol	25	170	0.224	0.033	0.257
A039	23950585	Pronamide	3,600	8,100,000	0.0016	6.91E−07	0.0016
A026	1918167	Propachlor	8.5	10,200	0.659	0.0005	0.659
A041	709988	Propanil	23	485	0.243	0.012	0.255
A227	79094	Propanoic acid	2,500		0.0022	–	0.0022
A225	2312358	Propargite/BPPS	1	7,100	5.60	0.0008	5.6
A226	139402	Propazine	875	1,900	0.0064	0.0029	0.009
A145	122429	Propham	400	3,300	0.014	0.0017	0.016
A034	5825876	Propionamide, 2−(m−Chlorophenoxy)	1,050		0.0053	–	0.0053
A201	114261	Propoxur \ Baygon	0.650	4,600	8.62	0.0012	8.6
A230	121211	Pyrethrin I	0.014	513	400	0.011	400
A231	121299	Pyrethrin II	0.014	3,400	400	0.0016	400
A275	8003347	Pyrethrins	0.014	513	400	0.011	400
A051	134316	Quinolinol sulfate			–	–	ND
A164	2439012	Quinomethionate/Oxythioquinox	0.74		7.57	–	7.6
A233	10453868	Resmethrin	0.0028	436	2,000	0.013	2,000
A234	299843	Ronnel	1		5.60	–	5.6
A235	83794	Rotenone \ Mexide	0.026	226	215	0.025	215
A237	1982496	Siduron	900		0.0062	–	0.0062
A239	122349	Simazine	10		0.560	–	0.560
A242	62748	Sodium fluoroacetate	2,000		0.0028	–	0.0028 (j)
A023	95067	Sulfallate \ CDEC	58		0.097	–	0.097

TABLE 2 TOXIC WEIGHTING FACTORS FOR PESTICIDE ACTIVE INGREDIENTS (PAIs)
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD PAI No.	CAS No.	Pollutant Name	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	TOXIC WEIGHTING FACTORS (TWFs) Chronic	Human	Total
A198	38527901	Sulprofos oxon	52		0.108	–	0.108 (k)
A270	26002802	Sumithrin \ Phenothrin	0.17		32.9	–	32.9
A252	34014181	Tebuthiuron	5,600	188,000	0.0010	2.98E−05	0.0010
A253	3383968	Temephos \ Abate	0.5		11.2	–	11.2
A254	5902512	Terbacil	3.5	70,000	1.60	8.00E−05	1.60
A255	13071799	Terbufos \ Counter	0.01	74	560	0.1	560
A256	5915413	Terbuthylazine	46		0.122	–	0.122
A257	886500	Terbutryn	8.2	26	0.683	0.215	0.898
A010	1940438	Tetrachlorophene	18.3		0.306	–	0.306
A258	58902	Tetrachlorophenol, 2,3,4,6−	10	3,000	0.560	0.0019	0.562
A084	961115	Tetrachlorvinphos \ Gardona \ Stirofos	4.3	1,200	1.30	0.0047	1.31
A179	3689245	Tetraethyldithiopyrophosphate	0.08	192	70.0	0.029	70.0
A271	7696120	Tetramethrin \ Neo−pynamin	0.7		8.00	–	8.0
A032	148798	Thiabendazole \ Mertect	365	47,500	0.015	0.0001	0.015
A100	23564069	Thiophanate ethyl	4,950		0.0011	–	0.0011
A260	23564058	Thiophanate methyl	89	2,800	0.063	0.0020	0.065
A261	137268	Thiram	1.05	472	5.33	0.012	5.3
A262	8001352	Toxaphene	0.0002	0.0075	28.000	747	28,747
A008	43121433	Triadimefon	500	36,400	0.011	0.0002	0.011
A269	2303175	Tri−allate \ Far−Go	4.9	171	1.14	0.033	1.18
A111	52686	Trichlorofon \ Dylox	0.265	74,800	21	0.0001	21
A015	93765	Trichlorophenoxyacetic acid, 2,4,5−	7.5	1,657	0.747	0.0034	0.750
A238	93721	Trichlorophenoxypropionic acid, 2,4,5−	6	330	0.933	0.017	0.950
A264	1582098	Trifluralin \ Treflan	1.9	4.1	2.95	1.37	4.3
A266	155044	Vancide 51Z \ Zetax			–	–	ND
A004	7779274	Vancide TH	36.7		0.1526	–	0.153
A249	1929777	Vernolate	11.5	220	0.487	0.025	0.512
A265	81812	Warfarin	0.34	25	16.5	0.224	16.7
A267	12122677	Zineb \ Dithane Z	9.70	3,170	0.5773	1.77E−03	0.579
A268	137304	Ziram \ Cymate	15	2.20E+08	0.373	2.55E−08	0.373

Notes:

* These pollutants are volatile priority pollutants. Therefore, the human health criteria (organisms only) has been replaced with the criteria for (water and organisms). See text for discussion.

a. The TWF for copper is reported for these compounds since the complexes could release copper into the environment. 12/06/91
b. The TWF of metham sodium (vapam) is used for these compounds due to structural similarity.
c. The TWF of warfarin is used for this compound due to structural similarity.
d. The TWF of hyamine 2389 is used for these structurally similar quaternary ammonium compounds.
e. The TWF of dodecylguanidine monoacetate is used for this compound due to structural similarity.
f. The TWF of benzethonium chloride is used for this compound due to structural similarity.
g. The TWF of ferbam is used for this compound due to structural similarity.
h. The TWF for the base metals of these compounds is reported assuming the toxicity is mainly due to the bound metal.
i. The TWF for tributyltin oxide is reported for these compounds since it is the most probable PAI related pollutant in wastewaters.
j. The TWF of 2−fluoroacetamide is used for this compound due to structural similarity.
k. The TWF of bolstar \ sulprofos is used for this compound due to structural similarity.

TABLE 3 TOXIC WEIGHTING FACTORS FOR PRIORITY POLLUTANTS
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD P No.	CAS No.	Pollutant Name	Volatiles	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	Human Health Ingesting Water & Organisms Value (ug/l)	TOXIC WEIGHTING FACTORS Chronic (1)	Human Organisms Only (2)	Human Water & Organisms (3)	Total (1 + 2)	Total (1 + 3) Volatiles
P001	83329	Acenaphthene	V	6.1	2,700	1,200	0.9180	0.0021	0.0047	0.920	0.923
P077	208968	Acenaphthylene	V	17			0.3294			0.329	0.329
P002	107028	Acrolein	V	11.4	780	320	0.4912	0.0072	0.0175	0.498	0.509
P003	107131	Acrylonitrile	V	378	6.7	0.59	0.0148	0.836	9.49	0.851	9.51
P089	309002	Aldrin		0.22	0.23	0.019	25.5	24		50	
P078	120127	Anthracene	V	0.030	4,800	3,300	187	0.001	0.002	187	187
P114	7440360	Antimony		30	4,300	14	0.187	1.3E−03		0.188	
P115	25541544	Arsenic (III)		190	1.4	0.18	0.0295	4.0		4.03	
P115	7440382	Arsenic (total)		190	1.40	0.18	0.0295	4.0	31.111	4.03	
P115	17428410	Arsenic (V)		42	1.4	0.18	0.1333	4.0		4.13	
P116	1332214	Asbestos									
P004	71432	Benzene	V	265	710	12	0.0211	0.0079	0.467	0.029	0.488
P005	92875	Benzidine		125	0.0054	0.0012	0.0448	1,037		1,037	
P072	56553	Benzo(a)anthracene		0.1	15.6	1.4	56.0	0.359		56.4	
P073	50328	Benzo(a)pyrene		0.050	0.311	0.028	112	18.0		130	
P074	205992	Benzo(b)fluoranthene			2.39	0.215		2.34		2.34	
P079	191242	Benzo(ghi)perylene		12.1	28.3	2.55	0.4628	0.198		0.661	
P075	207089	Benzo(k)fluoranthene	V		2.39	0.215		2.34	26.05	2.34	26.05
P117	7440417	Beryllium		5.3	1.32	0.077	1.06	4.24		5.30	
P102	319846	BHC, alpha−		14	0.130	0.039	0.4	43.1		43.48	
P103	319857	BHC, beta−			0.460	0.14		12.2		12.17	
P105	319868	BHC, delta−									
P104	58899	BHC, gamma− \ Lindane		0.080	0.625	0.186	70.0	8.96		78.96	
	608731	BHC, Technical grade		1	0.46	0.14	5.6	12.17		17.77	
P043	111911	Bis(2−chloroethoxy) methane									
P018	111444	Bis(2−chloroethyl) ether		19,000	14.0	0.31	2.9E−04	0.400		0.400	
P042	108601	Bis(2−chloroisopropyl) ether	V	6,300	4,360	34.7	8.9E−04	0.0013	0.161	0.00217	0.162
P066	117817	Bis(2−ethylhexyl) phthalate		360	59.0	17.6	0.02	0.0949		0.11	
P048	75274	Bromodichloromethane	V	21,600	36	2.5	2.6E−04	0.1556	2.24	0.1558	2.24
P046	74839	Bromomethane	V	550	4,700	57	0.0102	0.0012	0.10	0.011	0.11
P041	101553	Bromophenyl phenyl ether, 4−	V	46			0.1217			0.122	0.122
P067	85687	Butyl benzyl phthalate		220	5,200	3,000	0.0255	0.0011		0.0265	
P118	7440439	Cadmium		1.1	170	30	5.09	0.0329		5.12	
P091	57749	Chlordane		0.0043	0.0059	0.0058	1,302	949		2,251	

Source: Toxic Weighting Factors for Pesticide Active Ingredients and Priority Pollutants, U.S. EPA, March 18, 1992.

TABLE 3. TOXIC WEIGHTING FACTORS FOR PRIORITY POLLUTANTS
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD P No.	CAS No.	Pollutant Name	Volatiles	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	Human Health Ingesting Water & Organisms Value (ug/l)	TOXIC WEIGHTING FACTORS Chronic (1)	Human Organisms Only (2)	Human Water & Organisms (3)	Total (1 + 2)	Total (1 + 3) Volatiles
P007	108907	Chlorobenzene	V	17	21,000	680	0.33	2.7E−04	0.0082	0.33	0.34
P016	75003	Chloroethane		32,800			1.7E−04			1.71E−04	
P088	75014	Chloroethene	V	17,800	5,250	20	3.1E−04	0.0011	0.28	0.00138	0.280
P019	110758	Chloroethylvinyl ether, 2−		17,500			3.2E−04			0.00032	
P045	74873	Chloromethane	V	27,500	4,700	57	2.0E−04	0.0012	0.10	0.0014	0.10
P020	91587	Chloronaphthalene, 2−		16			0.3500			0.3500	
P024	95578	Chlorophenol, 2−		1,000	400	120	0.0056	0.0140		0.0196	
P040	7005723	Chlorophenylphenyl ether, 4−	V	12.9			0.4341			0.434	0.434
P119	16065831	Chromium (III)		210	670,000	33,000	0.0267	8.4E−06		0.0267	
P119	7440473	Chromium (total)		210	670,000	33,000	0.0267	8.4E−06		0.0267	
P119	18540299	Chromium (VI)		11	3,400	170	0.5091	0.0016		0.5107	
P076	218019	Chrysene	V	10.2	38.4	3.46	0.5490	0.146	1.62	0.695	2.17
P120	7440508	Copper		12			0.4667			0.467	
P121	57125	Cyanide		5.2	215,000	700	1.08	2.6E−05		1.077	
P094	72548	DDD		0.001	8.4E−03	8.3E−03	5,600	667		6,267	
P093	72559	DDE		0.001	5.9E−03	5.9E−03	5,600	949		6,549	
P092	50293	DDT		0.001	5.9E−03	5.9E−03	5,600	949		6,549	
P082	53703	Dibenzo(a,h)anthracene		7.02	0.111	0.01	0.7977	50.5		51.2	
P051	124481	Dibromochloromethane	V	2,035	44	3.8	0.0028	0.1273	1.47	0.1300	1.48
P025	95501	Dichlorobenzene, 1,2−	V	360	17,000	2700	0.0156	0.0003	0.002	0.0159	0.0176
P026	541731	Dichlorobenzene, 1,3−	V	1,510	2,600	400	0.0037	0.0022	0.014	0.00586	0.0177
P027	106467	Dichlorobenzene, 1,4−	V	763	3,900	590	0.0073	0.0014	0.009	0.00878	0.0168
P028	91941	Dichlorobenzidine, 3,3'−		21.8	0.770	0.4	0.2569	7.3		7.5	
P013	75343	Dichloroethane, 1,1−	V	2,750	92,300	3,900	0.0020	6.1E−05	0.0014	0.00210	0.00347
P010	107062	Dichloroethane, 1,2−	V	20,000	990	3.8	2.8E−04	0.0057	1.474	0.00594	1.474
P029	75354	Dichloroethene, 1,1−	V	2,400	32.0	0.57	0.0023	0.175	9.82	0.177	9.8
P030	156605	Dichloroethene, trans−1,2−	V	110,000	135,000	700	5.1E−05	4.1E−05	0.008	9.24E−05	0.0081
P044	75092	Dichloromethane	V	9,650	16,000	47	5.8E−04	0.0004	0.12	0.0009	0.12
P031	120832	Dichlorophenol, 2,4−		70	790	93	0.0800	7.1E−03		0.0871	
P032	78875	Dichloropropane, 1,2−	V	8,100	37,400	483	6.9E−04	1.5E−04	0.012	8.41E−04	0.0123
P033	542756	Dichloropropene, 1,3−	V	4.5	14,100	87	1.24	4.0E−04	0.0644	1.24	1.31
P090	60571	Dieldrin		0.0019	1.4E−03	1.3E−03	2,947	4,000		6,947	
P070	84662	Diethyl phthalate		10,000	118,000	23,000	5.6E−04	4.7E−05		6.07E−04	
P071	131113	Dimethyl phthalate		1,700	2,900,000	313,000	0.0033	1.9E−06		0.00330	

TABLE 3 TOXIC WEIGHTING FACTORS FOR PRIORITY POLLUTANTS
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD P No.	CAS No.	Pollutant Name	Volatiles	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	Human Health Ingesting Water & Organisms Value (ug/l)	TOXIC WEIGHTING FACTORS Chronic (1)	Human Organisms Only (2)	Human Water & Organisms (3)	Total (1 + 2)	Total (1 + 3) Volatiles
P034	105679	Dimethylphenol, 2,4−		1,000	1,400	470	0.0056			0.00560	
P068	84742	Di−n−butyl phthalate		35	12,000	2,700	0.1600	4.7E−04		0.160	
P060	534521	Dinitro−o−cresol, 4,6−	V	3.3	765	13.4	1.70	0.0073	0.418	1.70	2.11
P059	51285	Dinitrophenol, 2,4−		27.5	14,300	70	0.2036	3.9E−04		0.204	
P035	121142	Dinitrotoluene, 2,4−		583	42.0	0.5	0.0096	0.1333		0.1429	
P036	606202	Dinitrotoluene, 2,6−		398			0.0141			0.0141	
P069	117840	Di−n−octyl phthalate		3			1.87			1.87	
P037	122667	Diphenylhydrazine, 1,2−		13.5	5.40	0.41	0.4148	1.04		1.45	
P097	1031078	Endosulfan sulfate		0.056	2	0.93	100	2.8000		103	
P095	959988	Endosulfan, alpha−		0.056	2	0.93	100	2.8000		103	
P096	33213659	Endosulfan, beta−		0.056	2	0.93	100	2.8000		103	
P098	72208	Endrin		0.0023	0.810	0.76	2,435	6.91		2,442	
P099	7421934	Endrin aldehyde		0.0023	0.810	0.76	2,435	6.91		2,442	
P038	100414	Ethylbenzene	V	210	29,000	3,100	0.0267	0.0002	0.002	0.0269	0.0285
P039	206440	Fluoranthene		40	370	300	0.1400	0.015		0.155	
P080	86737	Fluorene	V	17	1500	730	0.3294	0.004	0.008	0.333	0.337
P100	76448	Heptachlor		0.0038	0.0021	0.0021	1,474	2,667		4,140	
P101	1024573	Heptachlor epoxide		0.0038	0.0011	0.0010	1,474	5,091		6,565	
P009	118741	Hexachlorobenzene	V	3.68	0.0074	0.0072	1.5	757	778	758	779
P052	87683	Hexachlorobutadiene	V	9.3	500	4.47	0.6022	0.0112	1.25	0.613	1.85
P053	77474	Hexachlorocyclopentadiene	V	5.2	17,500	242	1.08	3.2E−04	0.023	1.077	1.10
P012	67721	Hexachloroethane	V	540	89.0	20	0.0104	0.0629	0.280	0.0733	0.290
P083	193395	Indeno(1,2,3−cd)pyrene		12.1	28.3	2.55	0.4628	0.198		0.661	
P054	78591	Isophorone		5,850	6,000	84	9.6E−04	9.3E−04		1.89E−03	
P122	7439921	Lead		3.2		50	1.75			1.75	
P123	7439976	Mercury		0.012	0.146	0.144	467	38.4		505	
P055	91203	Naphthalene	V	620	6,501	3,774	0.0090	8.6E−04	0.0015	0.00989	0.0105
P124	7440020	Nickel		160	4,600	610	0.0350	0.0012		0.0362	
P056	98953	Nitrobenzene		460	1,900	17	0.0122	2.9E−03		0.0151	
P057	88755	Nitrophenol, 2−		2,315			0.0024			0.0024	
P058	100027	Nitrophenol, 4−	V	395			0.0142			0.0142	0.0142
P061	62759	Nitrosodimethylamine, N−	V	14,000	80	0.0069	4.0E−04	0.0700	812	0.0704	812
P063	621647	Nitrosodi−n−propylamine, N−			2.44	0.05		2.30		2.30	
P062	86306	Nitrosodiphenylamine, N−	V	1,000	160	50	0.0056	0.0350	0.112	0.0406	0.118

TABLE 3. TOXIC WEIGHTING FACTORS FOR PRIORITY POLLUTANTS
(CARCINOGENIC HUMAN HEALTH VALUES BASED ON A 10−5 RISK)

EAD P No.	CAS No.	Pollutant Name	Volatiles	Aquatic Life Chronic Value (ug/l)	Human Health Ingesting Organisms Only Value (ug/l)	Human Health Ingesting Water & Organisms Value (ug/l)	TOXIC WEIGHTING FACTORS Chronic (1)	Human Organisms Only (2)	Human Water & Organisms (3)	Total (1 + 2)	Total (1 + 3) Volatiles
P022	59507	Parachlorometacresol		1.5		3,000	3.73			3.73	
P112	12674112	PCB−1016		0.014	4.5E−04	4.4E−04	400	12,444		12,844	
P108	11104282	PCB−1221		0.014	4.5E−04	4.4E−04	400	12,444		12,844	
P109	11141165	PCB−1232		0.014	4.5E−04	4.4E−04	400	12,444		12,844	
P106	53469219	PCB−1242		0.014	4.5E−04	4.4E−04	400	12,444		12,844	
P110	12672296	PCB−1248		0.014	4.5E−04	4.4E−04	400	12,444		12,844	
P107	11097691	PCB−1254		0.014	4.5E−04	4.4E−04	400	12,444		12,844	
P111	11096825	PCB−1260		0.014	4.5E−04	4.4E−04	400	12,444		12,844	
P064	87865	Pentachlorophenol		13	29,000	1,000	0.4308	1.9E−04		0.431	
P081	85018	Phenanthrene	V	6.3	54	42	0.89	0.104	0.133	0.99	1.02
P065	108952	Phenol		750	4,600,000	21,000	0.0075	1.2E−06		0.00747	
P084	129000	Pyrene		10.1	38.4	3.46	0.5545	0.146		0.700	
P125	7782492	Selenium		5	9,000	170	1.12	6.2E−04		1.12	
P126	7440224	Silver		0.12	6	50	46.7	0.933		47.6	
P129	1746016	TCDD, 2,3,7,8−		3.8E−08	1.4E−07	1.3E−07	147,368,421	40,000,000		1.87E+08	
P015	79345	Tetrachloroethane, 1,1,2,2−	V	1,700	107	1.7	0.0033	0.0523	3.29	0.0556	3.30
P085	127184	Tetrachloroethene	V	840	88.5	8	0.0067	0.0633	0.70	0.0699	0.707
P006	56235	Tetrachloromethane	V	1,350	44.0	2.5	0.0041	0.1273	2.24	0.1314	2.24
P127	7440280	Thallium		40	48	13	0.1400	0.117		0.257	
P086	108883	Toluene	V	275	200,000	6,800	0.0204	2.8E−05	8.24E−04	0.0204	0.021
P113	8001352	Toxaphene		0.0002	0.0075	0.0073	28,000	747		28,747	
P047	75252	Tribromomethane	V	1,465	4,200	44	0.0038	0.0013	0.13	0.0052	0.13
P008	120821	Trichlorobenzene, 1,2,4−	V	286	230	183	0.0196	0.0243	0.031	0.0439	0.0501
P011	71556	Trichloroethane, 1,1,1−	V	2,000	1,030,000	18,400	0.0028	5.4E−06	3.04E−04	0.0028	0.0031
P014	79005	Trichloroethane, 1,1,2−	V	1,000	418	6	0.0056	0.0134	0.933	0.0190	0.939
P087	79016	Trichloroethene	V	2,200	923	31	0.0025	0.0061	0.181	0.0086	0.183
P023	67663	Trichloromethane	V	1,240	4,700	57	0.0045	0.0012	0.10	0.0057	0.10
P021	88062	Trichlorophenol, 2,4,6−		3.2	36.0	12	1.75	0.156		1.91	
P128	7440666	Zinc		110			0.0509			0.0509	

Notes: The total number of unique chemicals included is 126 excluding various metal oxidation states and alternative compound forms. The EAD P Number is the Engineering and Analysis Division's identification number for priority pollutants.

12/06/91

are shown in Table 2; toxic weighting factors for each priority pollutant are shown in Table 3. Some examples of the effects of different aquatic and human health criteria on weighting factors are shown in Table 4.

Table 4

Weighting Factors Based on Copper Freshwater Chronic Criteria

Pollutant	Human Health Criteria* (ug/l)	Aquatic Chronic Criteria (ug/l)	Weighting Calculation	Toxic Weighting Factor
Copper**	--	12.0	5.6/12.0	0.467
Hexavalent Chromium	3,400	11.0	5.6/3,400 + 5.6/11	0.511
Nickel	4,600	160.0	5.6/4,600 + 5.6/160	0.036
Cadmium	170	1.1	5.6/170 + 5.6/1.1	5.12
Benzene	12	265.0	5.6/12 + 5.6/265	0.488

Note: Criteria are maximum contamination thresholds. Using the above calculation, the greater the values for the criteria used, the lower the toxic weighting factor. Units for criteria are micrograms of pollutant per liter of water.

* Based on ingestion of 6.5 grams of fish per day.

** While the water quality criterion for copper has been revised (to 12.0 ug/l), the cost-effectiveness analysis uses the old criterion (5.6 ug/l) to facilitate comparisons with cost-effectiveness values for other effluent limitations guidelines. The revised higher criteria for copper results in a toxic weighting factor for copper not equal to 1.0 but equal to 0.467.

As indicated in Table 4, the toxic weighting factor is the sum of two criteria-weighted ratios: the "old" copper criterion divided by the human health criterion for the particular pollutant and the "old" copper criterion divided by the aquatic chronic criterion. For example, using the values reported in Table 4, 10.96 pounds of copper pose the same relative hazard in surface waters as one pound of cadmium since cadmium has a toxic weight 10.96 times (5.12/0.467=10.96) as large as the toxic weight of copper.

3. Pollution Control Options

As previously mentioned, two control options are evaluated in the cost-effectiveness analysis: a Treated Discharge Option and a Zero Discharge Option. The Treated Discharge Option limitations would be based on the use of hydrolysis, activated carbon, chemical oxidation, resin adsorption, solvent extraction, incineration and/or recycle/reuse to control the discharge of PAIs in wastewater. The Zero Discharge Option limitations would achieve zero discharge of pesticide manufacturing wastewater pollutants by using on-site and off-site incineration and/or

recycle/reuse.[8] For both regulatory options, the economic impacts on the facilities were calculated separately for direct and indirect dischargers. Impacts on direct dischargers were calculated for compliance with Best Available Technology (BAT) regulation; impacts on indirect dischargers were calculated for compliance with Pretreatment Standard for Existing Sources (PSES). Each discharge category was further analyzed by two subcategories: organic pesticide chemicals manufacturing (subcategory A) and metallo-organic pesticide chemicals manufacturing (subcategory B). Further information on the control options can be found in the Technical Development Document.

4. Calculation of Pollutant Removals

The reductions in pollutant loading to the receiving water body have been calculated for each control option. These at-stream pollutant removals are equal to end-of-pipe pollutant removals for direct dischargers. For indirect dischargers, however, at-stream and end-of-pipe removals may differ due to treatment at the POTW. Calculation of removals for direct and indirect dischargers is discussed below.

Direct dischargers

Current and post-treatment end-of-pipe annual pollutant loadings for each facility and each control option have been estimated. Removals are calculated as the difference between current and post-treatment discharges. Removals are then weighted using the copper-based toxic weighting factors and reported in pound-equivalents. Total removals associated with Subcategory A are calculated by summing removals over all direct discharging facilities. There are no removals for Subcategory B since direct discharge of such chemicals is already limited to zero by BPT regulations.

Indirect Dischargers

Indirect dischargers are treated differently from direct dischargers in the cost-effectiveness analysis for the priority pollutants[9]. A portion of the end-of-pipe pollutant loadings for indirect dischargers may be removed by

---

[8]The Zero Discharge Option would limit discharges to surface water only; discharges to other media may remain constant or increase as a result of changes in discharge to surface water. For example, pesticide manufacturing facilities could, theoretically, achieve compliance with a zero discharge effluent guideline by transferring the waste streams previously discharged to surface water to landfills, incinerators, or deep well injection sites.

[9] POTW removal efficiencies are available for priority pollutants only. POTW removal efficiencies for PAIs are assumed to be zero. A laboratory study of the PAI removal performance that would be achieved by biotreatment at well-operated POTWs applying secondary treatment is reported in the Domestic Sewage Study (see the Technical Development Document). However, the data used for that analysis were derived under laboratory conditions, and therefore tend to overestimate POTW removal efficiencies and are considered to be inappropriate

the POTW. Therefore at-stream loadings from an indirect discharging facility may be less than end-of-pipe loadings. As a result, the at-stream removal of pollutants due to PSES regulations are considered to be less than end-of-pipe removal of pollutants. The cost-effectiveness analysis calculates removals at-stream.

For example, if a facility is discharging 100 pounds of cadmium in its effluent stream to a POTW and the POTW has a removal efficiency for cadmium of 38 percent, then the cadmium discharged to surface waters is only 62 pounds. If the regulation results in a reduction of cadmium in the effluent stream to 50 pounds, then the amount discharged to surface waters is calculated as 50 pounds multiplied by the POTW removal efficiency factor (1-.38 or .62), i.e., 31 pounds (50 pounds x .62). Cost-effectiveness calculations reflect the fact that the actual reduction of pollutant discharge to surface waters is not 50 pounds (the change in the amount discharged to the POTW), but 31 pounds (= 62 - 31) (the change in the amount actually discharged to surface waters). The POTW removals factors used in the analysis are shown in Table 5.

5. Annualized Costs for Each Control Option

Full details of the methods by which the costs of complying with the regulatory options were estimated can be found in Chapter 8, Engineering Costs and Non-Water Quality Aspects, of the Technical Development Document. A brief summary of the compliance costs is provided below.

Three categories of compliance costs associated with pesticide manufacturing were evaluated: capital costs, land costs, and operating and maintenance costs (including sludge disposal and self-monitoring costs). While the capital and land costs are one-time "lump sum" costs, the operating and maintenance costs were evaluated on an annual basis. Capital and land costs are annualized using the weighted average cost of capital.[10] The capital and land are conservatively assumed to have a productive life of ten years. The capital and land costs are therefore adjusted to account for the cost of financing the investment (through equity and debt) over the ten year period. The adjusted total capital and land costs are then divided by ten to arrive at annualized costs. Total annualized costs are equal to annualized capital and land costs plus operating and maintenance costs. For facilities that both manufacture and formulate/package pesticides, the compliance costs apply only to the manufacturing operations of the facility. All of the compliance cost estimates are based on the assumption that, whenever possible, facilities will build on existing treatment.

---

for the cost-effectiveness analysis. A sensitivity analysis based on 50 percent POTW removal efficiency for all PAIs is considered in Appendix C.

[10]For details on the weighted average cost of capital see the discussion of the facility closure analysis in the Economic Impact Analysis of Proposed Effluent Limitations Guidelines and Standards for the Pesticide Manufacturing Industry.

TABLE 5*
POTW Removal Efficiencies for Priority Pollutants **

Pollutant Number	CAS Number	Pollutant Name	POTW Efficiency
092	50293	DDT	0.00
091	57749	Chlordane	0.00
104	58899	BHC, gamma- \ Lindane	0.00
090	60571	Dieldrin	0.00
061	62759	Nitrosodimethylamine, N-	0.00
098	72208	Endrin	0.00
094	72548	DDD	0.00
093	72559	DDE	0.00
048	75274	Bromodichloromethane	0.00
100	76448	Heptachlor	0.00
054	78591	Isophorone	0.00
062	86306	Nitrosodiphenylamine, N-	0.00
020	91587	Chloronaphthalene, 2-	0.00
037	122667	Diphenylhydrazine, 1,2-	0.00
102	319846	BHC, alpha-	0.00
105	319868	BHC, delta-	0.00
.	608731	BHC, Technical grade	0.00
063	621647	Nitrosodi-n-propylamine, N-	0.00
095	959988	Endosulfan, alpha-	0.00
101	1024573	Heptachlor epoxide	0.00
097	1031078	Endosulfan sulfate	0.00
116	1332214	Asbestos	0.00
129	1746016	TCDD, 2,3,7,8-	0.00
099	7421934	Endrin aldehyde	0.00
127	7440280	Thallium	0.00
.	7440382	Arsenic (total)	0.00
117	7440417	Beryllium	0.00
.	7440473	Chromium (total)	0.00
113	8001352	Toxaphene	0.00
111	11096825	PCB-1260	0.00
107	11097691	PCB-1254	0.00
108	11104282	PCB-1221	0.00
109	11141165	PCB-1232	0.00
110	12672296	PCB-1248	0.00
112	12674112	PCB-1016	0.00
.	16065831	Chromium (III)	0.00
.	17428410	Arsenic (V)	0.00
096	33213659	Endosulfan, beta-	0.00
106	53469219	PCB-1242	0.00
119	18540299	Chromium (VI)	0.18
057	88755	Nitrophenol, 2-	0.27
016	75003	Chloroethane	0.28
043	111911	Bis(2-chloroethoxy) methane	0.30

* Source: U.S. EPA (1992).
** POTW removal efficiencies are not available for active ingredients and are therefore assumed to be zero; a sensitivity analysis is reported in Appendix C.

TABLE 5 (continued)
POTW Removal Efficiencies for Priority Pollutants

Pollutant Number	CAS Number	Pollutant Name	POTW Efficiency
115	25541544	Arsenic (III)	0.39
039	206440	Fluoranthene	0.42
103	319857	BHC, beta-	0.43
064	87865	Pentachlorophenol	0.45
125	7782492	Selenium	0.46
045	74873	Chloromethane	0.48
021	88062	Trichlorophenol, 2,4,6-	0.50
034	105679	Dimethylphenol, 2,4-	0.51
124	7440020	Nickel	0.51
027	106467	Dichlorobenzene, 1,4-	0.52
002	107028	Acrolein	0.53
044	75092	Dichloromethane	0.54
042	108601	Bis(2-chloroisopropyl) ether	0.55
019	110758	Chloroethylvinyl ether, 2-	0.55
035	121142	Dinitrotoluene, 2,4-	0.55
036	606202	Dinitrotoluene, 2,6-	0.55
014	79005	Trichloroethane, 1,1,2-	0.56
070	84662	Diethyl phthalate	0.60
066	117817	Bis(2-ethylhexyl) phthalate	0.60
033	542756	Dichloropropene, 1,3-	0.60
123	7439976	Mercury	0.60
056	98953	Nitrobenzene	0.61
118	7440439	Cadmium	0.61
071	131113	Dimethyl phthalate	0.63
047	75252	Tribromomethane	0.65
114	7440360	Antimony	0.66
121	57125	Cyanide	0.70
013	75343	Dichloroethane, 1,1-	0.70
080	86737	Fluorene	0.70
041	101553	Bromophenyl phenyl ether, 4-	0.70
040	7005723	Chlorophenylphenyl ether, 4-	0.70
030	156605	Dichloroethene, trans-1,2-	0.71
023	67663	Trichloromethane	0.73
029	75354	Dichloroethene, 1,1-	0.75
058	100027	Nitrophenol, 4-	0.75
126	7440224	Silver	0.78
128	7440666	Zinc	0.78
068	84742	Di-n-butyl phthalate	0.79
018	111444	Bis(2-chloroethyl) ether	0.80
069	117840	Di-n-octyl phthalate	0.83
089	309002	Aldrin	0.83
120	7440508	Copper	0.84
085	127184	Tetrachloroethene	0.85
087	79016	Trichloroethene	0.87
006	56235	Tetrachloromethane	0.88
025	95501	Dichlorobenzene, 1,2-	0.89
010	107062	Dichloroethane, 1,2-	0.89

TABLE 5 (continued)
POTW Removal Efficiencies for Priority Pollutants

Pollutant Number	CAS Number	Pollutant Name	POTW Efficiency
026	541731	Dichlorobenzene, 1,3-	0.89
059	51285	Dinitrophenol, 2,4-	0.90
011	71556	Trichloroethane, 1,1,1-	0.90
067	85687	Butyl benzyl phthalate	0.90
028	91941	Dichlorobenzidine, 3,3'-	0.90
005	92875	Benzidine	0.90
009	118741	Hexachlorobenzene	0.90
051	124481	Dibromochloromethane	0.90
008	12082	Trichlorobenzene, 1,2,4-	0.91
015	79345	Tetrachloroethane, 1,1,2,2-	0.92
122	7439921	Lead	0.92
088	75014	Chloroethene	0.93
060	534521	Dinitro-o-cresol, 4,6-	0.93
038	100414	Ethylbenzene	0.94
082	53703	Dibenzo(a,h)anthracene	0.95
022	59507	Parachlorometacresol	0.95
012	67721	Hexachloroethane	0.95
004	71432	Benzene	0.95
046	74839	Bromomethane	0.95
053	77474	Hexachlorocyclopentadiene	0.95
081	85018	Phenanthrene	0.95
052	87683	Hexachlorobutadiene	0.95
055	91203	Naphthalene	0.95
024	95578	Chlorophenol, 2-	0.95
003	107131	Acrylonitrile	0.95
065	108952	Phenol	0.95
031	120832	Dichlorophenol, 2,4-	0.95
084	129000	Pyrene	0.95
079	191242	Benzo(ghi)perylene	0.95
083	193395	Indeno(1,2,3-cd)pyrene	0.95
074	205992	Benzo(b)fluoranthene	0.95
075	207089	Benzo(k)fluoranthene	0.95
077	208968	Acenaphthylene	0.95
086	108883	Toluene	0.96
007	108907	Chlorobenzene	0.96
078	120127	Anthracene	0.96
076	218019	Chrysene	0.97
072	56553	Benzo(a)anthracene	0.98
032	78875	Dichloropropane, 1,2-	0.98
001	83329	Acenaphthene	0.98
073	50328	Benzo(a)pyrene	0.99

6. Calculation of Cost-Effectiveness Values

Facilities are included in the analysis only if they have pollutant removal values associated with compliance costs. As a result, under both the Treated Discharge Option and the Zero Discharge Option, certain facilities with compliance costs are not included in the cost-effectiveness analysis. (See Appendix B for details of excluded facilities).

Cost-effectiveness values are calculated separately for direct and indirect dischargers and for Subcategory A and B. For any given subset of dischargers and subcategories subject to proposed regulatory controls, the cost-effectiveness value for a particular control option is calculated as the ratio of incremental annual cost of that option to the incremental pound-equivalents removed by that option. The incremental effectiveness may be viewed both in comparison to the baseline scenario and to another regulatory option. Cost-effectiveness values are reported in units of dollars per pound-equivalent of pollutant removed. For the purpose of comparing cost-effectiveness values of options under review to those of other promulgated rules, compliance costs used in the cost-effectiveness analysis are adjusted to 1981 dollars using Engineering News Record's Construction Cost Index (CCI). This adjustment factor is calculated as follows:

$$\text{Adjustment factor} = \frac{\text{1981 CCI}}{\text{1986 CCI}} = \frac{3535}{4295} = 0.823$$

The equation used to calculate cost-effectiveness is:

$$CE_k = \frac{ATC_k - ATC_{k-1}}{PE_k - PE_{k-1}}$$

where:

CE_k = cost-effectiveness of Option $_k$

ATC_k = total annualized treatment cost under Option $_k$

PE_k = pound-equivalents removed by Option $_k$

The numerator of the equation, ATC_k minus ATC_{k-1}, is simply the incremental annualized treatment cost in going from Option k-l to Option k. The denominator is similarly the incremental removals achieved in going from Option k-1 to Option k. Thus, cost-effectiveness measures the incremental unit cost of pollutant removal of Option k (in pound-equivalents).

The alternative (non-incremental) method of comparing cost-effective values of options to current treatment uses the same formula and sets the benchmark costs (ATC_{k-1}) equal to zero. For the non-incremental method, the benchmark pollutant loadings (PE_{k-1}) are set equal to the current at-stream loading.

7. Comparisons of Cost-Effectiveness Values

Two types of comparisons are typically done using cost-effectiveness values. Compliance costs (y axis) and pollutant removals (x axis) may be plotted to derive a marginal cost curve to determine which options offer the most cost-effective regulatory control. Alternatively, comparison of (non-incremental) cost-effective values can be used to assess the cost-effectiveness of controls relative to previously promulgated effluent limitations guidelines for other industries. Because only two options were analyzed in this cost-effectiveness report, graphical representation of the incremental effectiveness of control options is unnecessary; comparisons of non-incremental cost-effectiveness values are presented in the text of the results section.

SECTION 3: FINDINGS

The cost-effectiveness analysis is based on the Agency's estimates of the cost of compliance and wastewater pollution removals associated with two Best Available Technology (BAT) options for direct dischargers and two Pretreatment Standard for Existing Sources (PSES) options for indirect dischargers.

The number of direct discharging facilities included in the cost-effectiveness analysis total 24; the number of indirect discharging facilities included in the cost-effectiveness analysis total 27. These numbers are smaller than the total number of facilities covered by the regulation (32 directs and 36 indirects) because, as previously discussed, facilities are excluded from the cost-effectiveness analysis if the facility incurred no treatment costs (or treatment costs could not be estimated) or if pollutant loading data were not available.[11]

3.1 Best Available Technology

BAT cost-effectiveness was reviewed for two options: a Treated Discharge Option and a Zero Discharge Option. Under the Treated Discharge Option a combination of treatment technologies are employed to treat a facility's wastewater. Some pollutant discharge to surface water remains under this option. Under the Zero Discharge Option, all wastewater generated by a facility is hauled off-site for treatment and disposal. Although no regulated pollutants are released to surface water under the Zero Discharge Option, discharges of these pollutants to other media may remain constant or increase since this option can result in a transfer of pollutants between media. In contrast, pollutants no longer discharged to surface water under the Treated Discharge Option are destroyed rather than transferred.

Table 6 presents the cost-effectiveness data and results for direct dischargers for both options. As shown in the table, the cost-effectiveness for the Treated Discharge Option is $10 per pound-equivalent removed (Subcategory A).[12] By comparison, the cost-effectiveness value for the Zero Discharge Option is substantially higher at $2,841 per pound-equivalent removed. On an incremental basis, the Zero Discharge Option removes 176,935 pound-equivalents more than the Treated Discharge Option at a total incremental cost of $3,896,678,654, or about $22,000 per incremental pound-equivalent removed.

---

[11] One facility has both direct and indirect discharges.

[12] For comparative purposes, cost-effectiveness values are reported in 1981 year dollars.

Table 6
Cost-Effectiveness Values for BAT Options (Direct Dischargers)

Option Name (number of facilities)	Compliance Costs ($ 1981)	Total Removals (lbs)	Total Removals (copper lb-eq.)	Cost-Effectiveness Value ($/lb-eq.)
Treated Discharge Option (24)	$11,907,740	5,994,072	1,198,882	$9.93
Zero Discharge Option (24)	3,908,586,394	6,038,229	1,375,817	2,841

Table 7
Cost-Effectiveness Values for PSES Options (Indirect Dischargers)

Option Name (number of facilities)	Compliance Costs ($ 1981)	Total Removals (lbs)	Total Removals (copper lb-eq.)	Cost-Effectiveness Value ($/lb-eq.)
Treated Discharge Option Subcategory A (22)	$4,825,615	109,177	4,832,553	$1.00
Subcategory B (5) [1]	96,169	0.04	0.02	5,084,577
Zero Discharge Option Subcategory A (22)	370,296,232	110,495	4,860,338	76
Subcategory B (5) [1]	2,307,323	3	142	16,202

1. No new limitations are being proposed for the metallo-organic pesticide chemicals manufacturing subcategory (Subcategory B). The Agency proposes to reserve BAT regulations for manufacturers of Subcategory B pesticides.

3.2 Pretreatment Standard for Existing Sources

PSES cost-effectiveness was reviewed for the same two options as described above: a Treated Discharge Option and a Zero Discharge Option. Under the Treated Discharge Option a combination of technologies are employed to treat a facility's wastewater prior to discharge to a sewer or to a publicly-owned treatment works (POTW). The cost-effectiveness analysis of indirect dischargers measures removals as the change in at-stream pollutant loadings -- after the wastestream has passed through the POTW. Under the Zero Discharge Option, all wastewater generated by a facility is hauled off-site for treatment and disposal. The wastewater does not, therefore, pass through the sewerage system.

Table 7 presents the cost-effectiveness data and results for both subcategories of indirect dischargers for both options. As shown in the table, the cost-effectiveness for the Treated Discharge Option is $1 per pound-equivalent removed for Subcategory A. Under the Zero Discharge Option, the cost-effectiveness for Subcategory A is $76 [13]. Compared to the Treated Discharge Option, the Zero Discharge Option removes an incremental 27,785 pound-equivalents at a cost of about $365,500,000, or over $13,000 per incremental pound-equivalent removed.

The average cost-effectiveness for Subcategory B is over $5,000,000 for the Treated Discharge Option and about $16,000 for the Zero Discharge Option. In the case of Subcategory B facilities, therefore, the average cost-effectiveness value of the Zero Discharge Option is lower than that of the Treated Discharge Option. The Treated Discharge Option for Subcategory B has an extremely high cost-effective value since it achieves removal of only 0.02 pound-equivalents, compared with the removal of 142 pound-equivalents removed under the Zero Discharge Option. However, for both control options, the quantities of pollutant removed are small, because most of the pollutants are already being removed to meet local limits.

The cost-effectiveness values for the indirect dischargers (PSES) shown in Table 7 include the reduction that would occur in the discharge of Malathion. Until recently, a large amount of Malathion was being discharged indirectly by a single facility, and the cost-effectiveness estimates were developed assuming the occurrence of this discharge. EPA has recently been informed that this facility has ceased production of Malathion and does not plan to manufacture it in the future. As shown in Table 8, the cost-effectiveness value of $1 per pound-equivalent for the Treated Discharge Option would increase to $18 per pound-equivalent if the reduction of Malathion were not

---

[13]This figure of $76 would be the cost per pound-equivalent of removing pollutants from the media to which they are currently released. However, under the Zero Discharge Option the pollutants may be transferred to another medium, and there is no assurance that the pollutants would be destroyed. For example, pesticide manufacturing facilities could, theoretically, achieve compliance with the Zero Discharge Option by transferring wastestreams previously discharged to surface water to landfills, incinerators, or deep well injection sites.

Table 8
Cost-Effectiveness Values for PSES Options (Indirect Dischargers) excluding Malathion

Option Name (number of facilities)	Compliance Costs ($ 1981)	Total Removals (lbs)	Total Removals (copper lb-eq.)	Cost-Effectiveness Value ($/lb-eq.)
Treated Discharge Option Subcategory A (22)	$4,363,260	26,825	240,651	$18
Zero Discharge Option Subcategory A (22)	348,986,711	28,142	268,429	1300

considered in the cost-effectiveness analysis. Under the Zero Discharge Option, the costs would increase from $76 to $1,300 per pound-equivalent.

SECTION 4: COMPARISON OF COST-EFFECTIVENESS VALUES WITH PROMULGATED RULES

Table 9 presents the cost-effectiveness values for effluent limitations guidelines and standards issued for direct dischargers in other industries. The BAT Treated Discharge Option for pesticide manufacturers is relatively cost-effective when compared to the cost-effectiveness values for other effluent limitations guidelines.

Table 10 presents the cost-effectiveness values for effluent limitations guidelines issued for indirect dischargers in other industries. As with BAT, the PSES Treated Discharge Option for pesticide manufacturers is cost-effective when compared to the cost-effectiveness values for other effluent limitations guidelines.

Table 9
Industry Comparison of Cost-effectiveness for Direct Dischargers
(Toxic and Nonconventional Pollutants Only)
Copper Based Weights
(1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (000's)	Pounds Equivalent Remaining at Selected Option (000's)	Cost Effectiveness Selected Option(s) ($/lb-eq. removed)
Aluminum Forming	1,340	90	121
Battery Manufacturing	4,126	5	2
Canmaking	12	0.2	10
Coal Mining	BAT=BPT	BAT=BPT	BAT=BPT
Coil Coating	2,289	9	49
Copper Forming	70	8	27
Electronics I	9	3	404
Electronics II	NA	NA	NA
Foundries	2,308	39	84
Inorganic Chemicals I	32,503	1,290	++
Inorganic Chemicals II	605	27	6
Iron & Steel	40,746	1,040	2
Leather Tanning	259	112	BAT=BPT
Metal Finishing	3,305	3,268	12
Nonferrous Metals Forming	34	2	69
Nonferrous Metals Mfg I	6,653	313	4
Nonferrous Metals Mfg II	1,004	12	6
OCPSF**	54,225	9,735	5
Pharmaceuticals	208	4	1
Plastics Molding & Forming	44	41	BAT=BPT
Porcelain Enameling	1,086	63	6
Petroleum Refining	BAT=BPT	BAT=BPT	BAT=BPT
Pulp & Paper***	1,330	748	18
Textile Mills	BAT=BPT	BAT=BPT	BAT=BPT

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** Reflects costs and removals of both air and water pollutants.
*** PCB control for Deink subcategory only.
++ Less than a dollar.

Table 10
Industry Comparison of Cost-effectiveness for
Indirect Dischargers
(Toxic and Nonconventional Pollutants Only)
Copper Based Weights
(1981 Dollars)*

Industry	Pounds Equivalent Currently Discharged (To Surface Waters) (000's)	Pounds Equivalent Remaining at Selected Option (To Surface Waters) (000's)	Cost Effectiveness Selected Option(s) Beyond BPT** ($/lb-eq. removed)
Aluminum Forming	1,602	18	155
Battery Manufacturing	1,152	5	15
Can Making	252	5	38
Coal Mining***	N/A	N/A	N/A**
Coil Coating	2,503	10	10
Copper Forming	34	4	10
Electronics I	75	35	14
Electronics II	260	24	14
Foundries	2,136	18	116
Inorganic Chemicals I	3,971	3,004	9
Inorganic Chemicals II	4,760	6	++
Iron & Steel	5,599	1,404	6
Leather Tanning	16,830	1,899	111
Metal Finishing	11,680	755	10
Nonferrous Metals Forming	189	5	90
Nonferrous Metals Mfg I	3,187	19	15
Nonferrous Metals Mfg II	38	0.41	12
OCPSF	5,210	72	34
Pharmaceuticals	340	63	1
Plast. Molding & Forming	N/A	N/A	N/A
Porcelain Enameling	1,565	96	14
Pulp & Paper	N/A	N/A	N/A

* Although toxic weighting factors for priority pollutants varied across these rules, this table reflects the cost-effectiveness at the time of regulation.
** N/A: Pretreatment Standards not promulgated, or no incremental costs will be incurred.
*** Reflects costs and removals of both air and water pollutants.
**** Industry has no known or expected indirect dischargers.
++ Less than a dollar.

Table C.1
Cost-Effectiveness Values for PSES Options (Indirect Dischargers)
Assuming 50 percent POTW Removal Efficiency

Option Name (number of facilities)	Compliance Costs ($ 1981)	Total Removals (lbs)	Total Removals (copper lb-eq.)	Cost-Effectiveness Value ($/lb-eq.)
Treated Discharge Option Subcategory A (22)	$4,825,615	56,490	2,418,753	$2.00
Subcategory B (5) [1]	96,169	0.04	0.02	5,084,577
Zero Discharge Option Subcategory A (22)	370,296,232	57,158	2,432,652	152
Subcategory B (5) [1]	2,307,323	3	142	16,202

1. No new limitations are being proposed for the metallo-organic pesticide chemicals manufacturing subcategory (Subcategory B). The Agency proposes to reserve BAT regulations for manufacturers of Subcategory B pesticides.

Table C.2
Cost-Effectiveness Values for PSES Options (Indirect Dischargers) excluding Malathion
Assuming 50 percent POTW Removal Efficiency

Option Name (number of facilities)	Compliance Costs ($ 1981)	Total Removals (lbs)	Total Removals (copper lb-eq.)	Cost-Effectiveness Value ($/lb-eq.)
Treated Discharge Option Subcategory A (22)	$4,363,260	15,492	122,812	$36
Zero Discharge Option Subcategory A (22)	348,986,711	16,161	136,707	2553