A study on collaborative environmental risk management : modeling to facilitate the prevention of soil contamination by local governments, businesses, and local stakeholders

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APPENDIX I

Hazardous Ranking System Chemicals for NPL sites

(http://www.epa.gov/superfund/sites/npl/hrscomp.pdf)

HAZARD RANKING SYSTEM
Hazardous Substance Synonyms Report

CAS Number	Chemical Name	Synonym
000083-32-9	Acenaphthene	Acenaphthylene, 1,2-dihydro-
000208-96-8	Acenaphthylene	1,2-Dihydroacenaphthylene
000107-02-8	Acrolein	Propenal
000079-06-1	Acrylamide	Propenamide
000062-53-3	Aniline	Benzenamine
000120-12-7	Anthracene	Paranaphthalene
000056-55-3	Benz(a)anthracene	Benzanthrene
000071-43-2	Benzene	Coal naptha
000092-87-5	Benzidine	[1,1'-biphenyl]-4,4'-diamine
000050-32-8	Benzo(a)pyrene	Benz[a]pyrene
000205-99-2	Benzo(b)fluoranthene (Fluoranthene)	Fluoranthene
000207-08-9	Benzo(k)fluoranthene	Dibenzo[b,j]fluorene
000117-81-7	Bis(2-ethylhexyl) phthalate	Benzenedicarboxylic acid, bis(2-ethylhexyl) ester, 1,2-
000075-27-4	Bromodichloromethane	Dichlorobromomethane
000085-68-7	Butylbenzyl phthalate	1,2-benzenedicarboxylic acid, butyl phenylmethyl ester
000075-15-0	Carbon disulfide	Dithiocarbonic anhydride
000056-23-5	Carbon tetrachloride	Tetrachloromethane
000057-74-9	Chlordane	4,7-Methanoindan, 1,2,4,5,6,7,8,8-octachloro-3a,4,7,7a-tetrahydro-
005103-71-9	Chlordane, alpha-	cis-Chlordane
005103-74-2	Chlordane, gamma-	trans-Chlordane
000108-90-7	Chlorobenzene	Phenyl chloride
000067-66-3	Chloroform	Trichloromethane
007440-47-3	Chromium	Chrome
000218-01-9	Chrysene	Benzophenanthrene-1,2
000098-82-8	Cumene	Methylethylbenzene-1
000057-12-5	Cyanide	Hydrocyanic acid
000072-54-8	DDD	Dichlorodiphenyldichloroethane
000072-55-9	DDE	Dichlorodiphenyldichloroethylene, p,p-
000050-29-3	DDT	Dichlorodiphenyltrichloroethane, 4,4-
000084-74-2	Di-n-butyl phthalate	Benzenedicarboxylic acid, dibutyl ester, 1,2-
000117-84-0	Di-n-octyl phthalate	Benzenedicarboxylic acid, dioctyl ester, 1,2-
000053-70-3	Dibenz(a,h)anthracene	Dibenzo[a,h]anthracene, 1,2,5,6-
000132-64-9	Dibenzofuran	Diphenylene oxide
000096-12-8	Dibromo-3-chloropropane, 1,2-	Nemagon
000106-93-4	Dibromoethane, 1,2-	Ethylene bromide (EDB)
000106-46-7	Dichlorobenzene, 1,4-	Para-dichlorobenzene
000075-34-3	Dichloroethane, 1,1-	Ethylidene chloride
000107-06-2	Dichloroethane, 1,2-	Ethylene dichloride

Hazardous Ranking System Chemicals for NPL sites (Continued)

CAS Number	Chemical Name	Synonyms
000075-35-4	Dichloroethylene, 1,1-	Dichloroethylene, 1,1-
000156-59-2	Dichloroethylene, cis-1,2-	cis-dichloroethylene
000156-60-5	Dichloroethylene, trans-1,2-	1,2-dichloroethylene
000120-83-2	Dichlorophenol, 2,4-	Dichlorophenol, 4,6-
000078-87-5	Dichloropropane, 1,2-	Propylene chloride
000542-75-6	Dichloropropene, 1,3-	Dichloropropylene, 1,3-
000060-57-1	Dieldrin	Aldrin epoxide
000084-66-2	Diethyl phthalate	Benzenedicarboxylic acid, didecyl ester, 1,2-
000105-67-9	Dimethyl phenol, 2,4-	1-Hydroxy-2,4-dimethylbenzene
000099-65-0	Dinitrobenzene, 1,3-	Dinitrobenzene, 1,2-
000122-66-7	Diphenylhydrazine, 1,2-	Hydrazodibenzene
000100-41-4	Ethyl benzene	Phenylethane
000075-00-3	Ethyl chloride	Chloroethane
000086-73-7	Fluorene	Methylenebiphenyl, 2,2-
007782-41-4	Fluorine	Fluorine-19
000076-44-8	Heptachlor	Chlorochlordene, 3-
001024-57-3	Heptachlor epoxide, alpha, beta, gamma	Epoxyheptachlor
000118-74-1	Hexachlorobenzene	Perchlorobenzene
000087-68-3	Hexachlorobutadiene	Perchlorobutadiene
000319-84-6	Hexachlorocyclohexane, alpha-	alpha-BHC
000319-85-7	Hexachlorocyclohexane, beta-	beta-BHC
000302-01-2	Hydrazine	Diamine
007783-06-4	Hydrogen sulfide	Hydrosulfuric acid
000058-89-9	Lindane	Hexachlorocyclohexane- gamma
000072-43-5	Methoxychlor	(2,2,2-trichloroethylidiene)bis(4-methoxy-benzene), 1,1'-
000298-00-0	Methyl Parathion	Dimethyl p-nitrophenyl thiophosphate
000078-93-3	Methyl ethyl ketone	Butanone
000108-10-1	Methyl isobutyl ketone	Methyl-2-pentanone, 4-
000106-44-5	Methyl phenol, 4-	Methyl phenol, 4-
000075-09-2	Methylene chloride (dichloromethane)	Dichloromethane
000091-57-6	Methylnaphthalene, 2-	Methylnaphthalene, 2-
000091-20-3	Naphthalene	Tar camphor
000086-30-6	Nitrosodiphenylamine, N-	Diphenylnitrosamine : Nitrosophenylbenzeneamine, –
000085-01-8	Phenanthrene	Phenanthren
000108-95-2	Phenol	Phenyl alcohol
001336-36-3	Polychlorinated biphenyls (PCBs)	Polychlorinated biphenyls
000129-00-0	Pyrene	Benzo(def)phenanthrene

Hazardous Ranking System Chemicals for NPL sites (Continued)

CAS Number	Chemical Name	Synonyms
000100-42-5	Styrene	Vinylbenzene
000095-94-3	Tetrachlorobenzene, 1,2,4,5-	Tetrachlorobenzene, s-
001746-01-6	Tetrachlorodibenzo-p-dioxin 2,3,7,8- (TCDD)	2,3,7,8-Tetrachlorodibenzo-p-dioxin : Tetrachlorodibenzo-p-dioxin, 2,3,7,8-
000079-34-5	Tetrachloroethane, 1,1,2,2-	Acetylene tetrachloride
000127-18-4	Tetrachloroethylene	Tetrachloroethylene
007440-29-1	Thorium 232 (radionuclide)	Thorium 232
000108-88-3	Toluene	Methyl benzene
008001-35-2	Toxaphene	Chlorinated camphene
000071-55-6	Trichloroethane, 1,1,1-	Methyl chloroform
000079-00-5	Trichloroethane, 1,1,2-	Vinyl trichloride
000079-01-6	Trichloroethylene (TCE)	Trichloroethene
000075-69-4	Trichlorofluoromethane	Freon 11
001582-09-8	Trifluralin (Treflan)	Treflan
007440-61-1	Uranium 238(+D) (radionuclide)	Uranium 238
000108-05-4	Vinyl acetate	Acetic acid, vinyl ester
000075-01-4	Vinyl chloride	Chloroethene
000108-38-3	Xylene, m-	Dimethyl benzene, 1,3-
000095-47-6	Xylene, o-	Methyltoulene, o-
000106-42-3	Xylene, p-	Dimethylbenzene, 1,4-

APPENDIX I (Continued)

German Soil Contamination Trigger and Precautionary Values

(Federal Ministry of the Environment, Nature Conservation and Nuclear Safety, Federal Soil Protection and Contaminated Sites Ordinance (BBodSchV), July 12. 1999, Annex 2, pp. 50-56)

Action, trigger and precautionary values

1. Soil - human health pathway (direct contact)

1.1 Definition of uses

a) Playgrounds

Places for children that are generally used for playing, without the play sand in sandpits. If necessary, officially designated playgrounds must be evaluated on the basis of public health standards.

b) Residential areas

Areas serving housing purposes, including back gardens or any other gardens of similar use, including where they are not represented or specified under planning law within the meaning of the Building Use Ordinance, except for parks and recreational facilities, playgrounds, as well as paved traffic surfaces.

c) Parks and recreational facilities

Facilities serving social, health and sports purposes, in particular public and private green areas as well as unpaved areas that are regularly accessible and used in a comparable way.

d) Plots of land used for industrial and commercial purposes

Unpaved areas within workplaces or manufacturing plants which are used only during working hours.

1.2 Action values pursuant to Article 8 (1) second sentence No. 2 of the Federal Soil Protection Act for the direct intake of dioxins/furanes at playgrounds, in residential areas, parks and recreational facilities, and plots of land used for industrial and commercial purposes (in ng/kg dry matter, fine soil, analysis according to Annex 1).

	Action values [ng I-TEq/kg TM]*)			
Substance	Playgrounds	Residential areas	Parks and recreational facilities	Land used for industrial and commercial purposes
Dioxins/furanes (PCDD/F)	100	1,000	1,000	10,000

*) Sum of the 2,3,7,8-TCDD-toxicity equivalents (according to NATO/CCMS).

1.3 Application of the Action Values

In the event of dioxin-containing lye residues from copper slate, the action values, due to the low level of resorption in the human organism, must be applied not directly to protect human health but for long-term risk prevention.

1.4 Trigger values pursuant to Article 8 (1) second sentence No. 1 of the Federal Soil Protection Act for the direct intake of pollutants at playgrounds, in residential areas, parks and recreational facilities, and plots of land used for industrial and commercial purposes (in mg/kg dry matter, fine soil, analysis according to Annex 1)

	Trigger values [mg/kg TM]			
Substance	Playgrounds	Residential areas	Parks and recreational facilities	Land used for industrial and commercial purposes
Arsenic	25	50	125	140
Lead	200	400	1,000	2,000
Cadmium	10[1)]	20[1)]	50	60
Cyanides	50	50	50	100
Chromium	200	400	1,000	1,000
Nickel	70	140	350	900
Mercury	10	20	50	80
Aldrin	2	4	10	--
Benzo(a)pyrene	2	4	10	12
DDT	40	80	200	--
Hexachlorobenzene	4	8	20	200
Hexachlorocyclo-hexane (HCH-mix or β-HCH)	5	10	25	400
Pentachlorophenol	50	100	250	250
Polychlorinated biphenyls (PCP_6)[2)])	0.4	0.8	2	40

1) In back gardens and small gardens where children stay and food plants are grown, the trigger value 2.0 mg/kg TM must be applied in the case of cadmium.
2) Where PCB total contents are determined, the measured values must be divided by a factor of 5.

2. Soil – plant pathway

2.1 Definition of uses

a) Agriculture

areas for the cultivation of varying field crops, including vegetables and field forage plants; this also includes areas used for commercial gardening

b) Vegetable garden

back garden, small garden and any other garden areas used for growing food crops

c) Grassland

permanent green areas

2.2 Trigger and action values pursuant to Article 8 (1) second sentence Nos. 1 and 2 of the Federal Soil Protection Act for the pollutant transition soil - plant in agricultural land and in vegetable gardens, with regard to plant quality (in mg/kg dry matter, fine soil, analysis according to Annex 1)

	Agriculture, vegetable garden		
Substance	Method[1)]	Trigger value	Action value
Arsenic	KW	200[2)]	--
Cadmium	AN	--	0.04/0.1[3)]
Lead	AN	0.1	--
Mercury	KW	5	
Thallium	AN	0.1	--
Benzo(a)pyrene	--	1	--

1) Extraction process for arsenic and heavy metals: AN - ammonium nitrate, KW = aqua regia (Königswasser)
2) In the case of soils with temporarily decreasing conditions, a trigger value of 50 mg/kg dry matter must be applied.
3) In areas that are used for growing bread wheat or strongly cadmium-accumulating vegetables, an action value of 0.04 mg/kg dry matter must be applied; otherwise, the action value is 0.1 mg/kg dry matter

2.3 Action values (pursuant to Article 8 (1) second sentence No. 2 of the Federal Soil Protection Act) in relation to plant quality for the pollutant transition soil - plant on grassland areas (in mg/kg dry matter, fine soil, arsenic and heavy metals in aqua regia extract, analysis according to Annex 1)

	Grassland
Substance	Action value
Arsenic	50
Lead	1,200
Cadmium	20
Copper	1,300 [1)]
Nickel	1,900
Mercury	2
Thallium	15
Polychlorinated biphenyls (PCB_6)	0.2

1) Where sheep are kept on grassland, the applicable action value is 200 mg/kg dry matter.

2.4 Trigger values pursuant to Article 8 (1) second sentence No. 1 of the Federal Soil Protection Act for the pollutant transition soil - plant on agricultural land, with regard to growth impairments of cultivated plants (in mg/kg dry matter, fine soil, in ammonium nitrate extract, analysis according to Annex 1)

	Agriculture
Substance	Trigger value
Arsenic	0.4
Copper	1
Nickel	1.5
Zinc	2

2.5 Application of the trigger and action values

The trigger and action values must be applied in the assessment of pollutant concentrations at soil depths ranging from 0 to 30 cm for agricultural land and in vegetable gardens, as well as soil depths ranging from 0 to 10 cm for grassland according to Annex 1 No. 2.1 table 1. For greater soil depths referred to in Annex 1 No. 2.1 table 1, the values must be multiplied by a factor of 1.5.

3. Soil – groundwater pathway

3.1 Trigger values for the assessment of the soil - groundwater pathway pursuant to Article 8 (1) second sentence No. 1 of the Federal Soil Protection Act (in µg/l, analysis according to Annex 1)

Inorganic substances	Trigger value [µg/l]
Antimony	10
Arsenic	10
Lead	25
Cadmium	5
Chromium, total	50
Chromate	8
Cobalt	50
Copper	50
Molybdenum	50
Nickel	50
Mercury	1
Selenium	10
Zinc	500
Tin	40
Cyanides, total	50
Cyanides, volatile	10
Fluoride	750

Organic substances	Trigger value [µg/l]
Petroleum hydrocarbons [1]	200
BTEX [2]	20
Benzene	1
Volatile halogenated hydrocarbons [3]	10
Aldrin	0.1
DDT	0.1
Phenols	20
PCB, total [4]	0.05
PAH, total [5]	0.20
Naphthalene	2

1) n-alkanes (C10 C39), isoalkanes, cycloalkanes and aromatic hydrocarbons
2) Volatile aromatic hydrocarbons (benzene, toluene, xylenes, ethylbenzene, styrene, cumene)
3) Volatile halogenated hydrocarbons (sum of the halogenated C1 and C2 hydrocarbons)
4) PCB, total: sum of the polychlorinated biphenyls; as a rule, determination by way of the 6 congeners according to Ballschmiter pursuant to Ordinance on Waste Oils (DIN 51527) multiplied by a factor of 5; if applicable, for example in the case of a known substance spectrum, simple formation of the sum of all relevant individual substances (DIN 38407-32 or 3-3).
5) PAH, total: sum of the polycyclic aromatic hydrocarbons without napththalene and methylnaphthalenes; as a rule, determination by way of the sum of 15 individual substances according to the list of the US Environmental Protection Agency (EPA) without naphthalene; if applicable, inclusion of other relevant PAHs (e.g. quinolines).

3.2 Application of the trigger values

a) The trigger values are applicable to the transition area from the unsaturated to the water-saturated soil zone (place of assessment). The place where the soil samples are taken is not necessarily identical with the place of assessment for the groundwater.

b) When assessing whether the trigger values for leachate are likely to be exceeded at the place of assessment, account must be taken of changes in pollutant concentrations in the leachate passing through the unsaturated soil zone, as well as of the isobaths of the groundwater table and their variations.

c) In the case of abandoned waste deposits, it is generally not expedient to estimate pollutant concentrations in the leachate on the basis of material tests because of inhomogeneities in the deposited wastes. This applies accordingly to abandoned industrial sites showing particularly uneven patterns of pollutant distribution. In these cases, the pollutant concentrations in the leachate can be estimated by drawing conclusions or calculating back from flow-off measurements in the groundwater, in particular by giving consideration to the substance concentration in the influx.

d) If the pollutant concentrations in the leachate can be measured directly, soil samples must, where possible, be taken at the place of assessment for the groundwater.

e) If adverse soil alterations and contaminated sites are located in the water-saturated soil zone, they must be examined in accordance with the applicable provisions of water law to assess their risk for the groundwater.

f) When trigger values are applied, account must be taken of the geogenic background of the groundwater region in question.

4. Precautionary values for soils pursuant to Article 8 (2) No. 1 of the Federal Soil Protection Act (analysis according to Annex 1)

4.1 Precautionary values for metals
(in mg/kg dry matter, fine soil, aqua regia decomposition)

Soils	Cadmium	Lead	Chromium	Copper	Mercury	Nickel	Zinc
Soil type *clay*	1.5	100	100	60	1	70	200
Soil type *loam/silt*	1	70	60	40	0.5	50	150
Soil type *sand*	0.4	40	30	20	0.1	15	60
Soils with naturally increased and settlement-related increased background concentrations over large areas	safe, provided that the release of pollutants or additional inputs pursuant to Article 9 (2) and (3) of this Ordinance do not give reason to expect any adverse impacts on the soil functions						

4.2 Precautionary values for organic substances
(in mg/kg dry matter, fine soil)

Soils	Polychlorinated biphenyls (PCB_6)	Benzo(a)pyrene	Polycyclic aromatic hydrocarbons (PAH_{16})
Humus content > 8 %	0.1	1	10
Humus content ≤ 8 %	0.05	0.3	3

4.3 Application of the precautionary values

a) The precautionary values are differentiated by the main soil types in accordance with the Pedological Mapping Guide, 4th edition, corrected reprint 1996; they consider the precautionary protection of the soil functions in the case of sensitive uses. Agricultural soil use is governed by Article 17 (1) of the Federal Soil Protection Act.

b) Highly silty sands must be evaluated according to soil type loam/silt.

c) For the precautionary values of table 4.1, the acid content of the soils must be considered as follows:
   - For soils of soil type clay with a pH-value < 6.0, cadmium, nickel and zinc are subject to the precautionary values for soil type loam/silt.
   - For soils of soil type loam/silt with a pH-value of < 6.0, cadmium, nickel and zinc are subject to the precautionary values for soil type sand. Article 4 (8) second sentence of the Sewage Sludge Ordinance of 15 April 1992 (BGBl. I p. 912), last amended by the Ordinance of 6 March 1997 (BGBl. I p. 446) remains unaffected.
   - For soils with a pH-value of < 5.0, the precautionary values for lead must be reduced in accordance with the first two indents above.

d) The precautionary values of table 4.1 are not applied to soils and soil horizons with a humus content exceeding 8 %. If applicable, the competent authorities may take region-specific decisions for these soils.

5. Permissible additional annual pollutant loads through all pathways pursuant to Article 8 (2) No. 2 of the Federal Soil Protection Act (in g/ha)

Element	Load [g/ha a]
Lead	400
Cadmium	6
Chromium	300
Copper	360
Nickel	100
Mercury	1.5
Zinc	1,200

APPENDIX I (Continued)

Environmental Quality Standards under the Soil Contamination Countermeasures Law

(Ministry of the Environment homepage: http://www.env.go.jp)

Substance	Target Level of soil quality examined through leaching and content tests
cadmium	0.01 mg/l in sample solution and less than 1 mg/kg in rice for agriculture land
total cyanide	not detectable in sample
organic phosphorus	not detectable in sample
lead	0.01 mg 1or less in sample solution
chromium (VI)	0.01 mg 1or less in sample solution
arsenic	0.01 mg/l in sample solution.and less than 15 mg/kg in soil for rice paddies
total mercury	0.0005 mg 1 or less in sample solution
alkyl mercury	not detectable in sample
PCBs	not detectable in sample
copper	less than 125 mg kg in soil for rice paddies
dichloromethane	0.02 mg 1 or less in sample solution
carbon tetrachloride	0.02 mg/l or less in sample solution
1,2-dichloroethane	0.004 mg 1 or less in sample solution
1,1-dichloroethylene	0.02 mg 1 or less in sample solution
cis-1,2-dichloroethylene	0.04 mg/l or less in sample solution
1,1,1-trichloroethane	1 mg/l or less in sample
1,1,2-trichloroethane	0.006 mg 1 or less in sample
trichloroethylene	0.03 mg/l or less in sample
tetrachloroethylene	0.01 mg/l or less in sample
1,3-dichloropropene	0.002 mg 1 or less in sample
thiuram	0.006 mg/l or less in sample
simazine	0.003 mg/l or less in sample
thiobencarb	0.02 mg 1 or less in sample solution
benzene	0.01 mg 1 or less in sample
selenium	0.01 mg/l or less in sample

APPENDIX II

Data from environmental reports by U.S. and Japanese firms reported in Chapter Four.

Table 1 A: United States Paper & Pulp Company Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
International Paper	3	3	3	3	3	3	3	3	3	3
Georgia Pacific	3	3	3	3	3	3	3	3	3	1
Weyerhaeuser	3	3	3	3	3	3	3	3	3	2
Kimberly-Clark	3	3	3	3	3	3	3	3	3	3
Procter & Gamble	3	3	3	3	3	3	3	3	3	1
Smurfit-Stone	3	3	3	3	3	3	3	3	3	3
Boise	3	3	3	3	3	3	3	3	3	3
Mead Westvaco	3	3	3	3	3	3	3	3	3	1
Temple-Inland	3	3	3	3	3	3	3	3	3	2
Sonoco	2	2	2	2	2	2	2	1	1	1
Average Scores	**2.9**	**2.9**	**2.9**	**2.9**	**2.9**	**2.8**	**2.9**	**2.8**	**2.8**	**2**

Table 1 B: Japanese Paper & Pulp Company Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
Nippon Unipac	3	2	3	3	1	1	3	2	1	2
Oji Paper	2	1	2	2	1	1	2	1	1	2
Daio Paper	3	2	2	3	1	1	3	1	1	3
Rengo	2	1	1	1	2	2	2	1	1	1
Sumitomo	3	1	3	1	1	2	3	1	1	3
Mitusbishi Paper	3	1	3	2	1	2	2	1	1	3
Unicharm	3	3	3	3	2	3	3	1	1	3
Daiken	2	1	2	1	1	1	1	1	1	2
Tomoku	1	1	1	1	1	1	1	1	1	1
Hokuetsu Paper	3	3	3	3	3	2	1	1	1	3
Average Scores	**2.5**	**1.6**	**2.4**	**2**	**1.4**	**1.6**	**2**	**1.1**	**1**	**2.3**

Data from environmental reports by U.S. and Japanese firms (Continued)

Table 2 A: United States Chemical Company Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
Dow Chemical	3	3	3	3	3	3	3	3	3	[5]1
DuPont	3	3	3	3	3	3	3	3	3	[5]1
ExxonMobil	3	3	3	3	3	3	3	3	3	[5]1
General Electric	3	3	3	3	3	3	3	3	[4]3	3
*Chevron Phillips	3	3	3	1	1	3	1	1	1	1
Huntsman Corp.	3	[1]3	3	[3]3	3	3	3	1	3	1
PPG Industries	3	1	3	3	1	1	1	1	1	3
Equistar Chemical	3	[2]3	3	3	3	3	3	1	1	1
Air Products	3	3	3	3	3	3	3	3	3	2
Rohm and Haas	3	[2]3	3	3	3	3	1	1	1	1
Average Scores	**3**	**2.8**	**3**	**2.8**	**2.6**	**2.8**	**2.4**	**2.0**	**2.3**	**1.5**

*Brief report, [1]PIM (Proactive Issue Mgmt), [2]Responsible Care principles, [3]Some external audits, [4]Fines increased, [5] According to report system meets or exceeds ISO 14001 standard.

Table 2 B: Japanese Chemical Company Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
Sumitomo	3	3	3	3	3	3	1	3	3	3
Mitsui	3	3	3	3	3	3	1	3	3	3
Dainippon Ink	3	3	3	[4]3	3	3	[6]3	3	3	3
*Mitsubishi	[1]3	3	3	3	3	3	3	3	3	3
Toray Industries	3	3	3	[4]3	[5]3	3	3	1	3	[5]3
Asahi Kasei	3	3	3	3	3	3	3	3	2	3
*Teijin	3	[2]3	[2]3	3	3	3	3	3	3	3
Shin-Etsu	3	3	3	3	3	3	3	3	3	3
Hitachi Chemical	3	3	3	3	3	3	3	3	3	3
Nippon Steel Chem	3	3	[2]3	3	1	1	1	1	1	3
Average Scores	**3**	**3**	**3**	**3**	**2.8**	**2.8**	**2.4**	**2.6**	**2.7**	**3**

*Detailed report, [1]Chief Green Officer, [2]CRO (Chief Risk Mgmt Officer), [3]Responsible Care, [4]No external audit system, [5]Only for management & New employees, [6]Not good education and information system.

Data from environmental reports by U.S. and Japanese firms (Continued)

Table 3 A: United States Construction Company Environment Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
Bechtel	3	[1]3	[1]3	[1]3	[1]3	3	3	3	1	1
*Centex	1	1	1	1	1	1	1	1	1	1
**Fluor	3	3	3	3	3	3	3	3	3	3
*The Turner Corp	1	1	1	1	1	1	1	1	1	1
Skanska US Inc.	3	3	3	3	3	3	3	3	1	3
*Peter Kiewit	1	1	1	1	1	1	1	1	1	1
Kellogg Brown & Root	3	3	3	3	3	3	3	3	3	2
The Clark Group	1	1	1	1	1	1	1	1	1	1
Foster Wheeler	3	3	3	3	3	3	1	1	1	1
Jacobs	3	3	[1]3	[1]3	1	1	1	1	1	1
Average Scores	**2.2**	**2.1**	**2**	**2**	**1.8**	**2**	**1.8**	**1.8**	**1.4**	**1.5**

*No environmental report, **Detailed report, [1]No specific mention, but have some system.

Table 3 B: Japanese Construction Companies Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
Kashima	3	3	3	3	1	3	3	3	1	1
Taisei Const.	3	3	3	3	3	3	3	1	1	3
Shimizu Const.	3	3	3	3	3	3	3	1	1	[2]2
*Obayashi Gumi	3	3	3	3	3	3	3	3	3	3
Sekisui House	3	3	3	3	3	3	3	1	1	3
[1]Daiwa House	3	3	3	3	3	1	1	1	1	3
Sumitomo Forestry	3	3	3	3	3	3	3	1	1	3
Toda Const	3	3	3	3	3	3	3	3	3	3
Maeda	3	3	3	3	[1]3	1	3	3	3	1
Nishimatsu Const.	3	3	3	3	3	3	3	3	1	3
Average Scores	**3**	**3**	**3**	**3**	**2.7**	**2.6**	**2.8**	**2**	**1.6**	**2.5**

*Detailed report, [1]Brief report, [2]Engineering department is certified others have equivalent system.

Data from environmental reports by U.S. and Japanese firms (Continued)

Table 4 A: United States Beverage Companies Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
Coca-Cola	[1]3	1	3	[4]3	3	3	3	3	3	1
Kraft Foods	3	3	[3]3	3	3	3	3	1	1	1
PepsiCo	3	3	[2]3	3	3	3	3	1	1	1
Anheuser-Busch	3	3	[2]3	3	3	3	3	3	3	1
Brown Forman	1	1	1	1	1	1	1	1	1	1
National Bev.	1	1	1	1	1	1	1	1	1	1
Constellation Brands	3	3	3	3	1	1	1	1	1	1
Coors	3	3	3	3	3	3	3	3	1	1
Starbucks	3	3	3	3	3	3	3	1	1	1
E & J Gallo	3	3	1	1	1	1	1	1	1	1
Average Scores	**2.5**	**2.4**	**2.1**	**2.3**	**2.2**	**2.2**	**2.2**	**1.6**	**1.4**	**1**

[1]New program, [2]High level system, [3]External audits, [4]Insufficient improvements.

Table 4 B: Japanese Beverage Companies Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
Kirin Brewery	3	1	[2]3	3	3	3	3	1	1	3
Asahi Brewery	3	3	[2]3	3	3	3	3	1	1	3
Suntory Brewery	3	3	3	3	3	3	3	1	1	3
Calpis	3	3	3	3	3	3	3	1	3	3
Itoen	3	3	3	3	[3]3	[4]3	[5]3	1	1	3
Sapporo	3	3	3	3	3	1	3	1	1	3
Takara Shuzo	3	3	3	3	1	1	3	3	3	3
**Ajinomoto	[1]3	3	3	3	3	3	3	3	3	3
Otsuka	3	3	3	3	3	3	3	1	1	3
*Hakutsuru	3	3	3	3	1	1	1	1	1	3
Average Scores	**3**	**2.8**	**3**	**3**	**2.6**	**2.4**	**1.2**	**1.2**	**1.4**	**3**

*Brief and lacking detail, **Very detailed report, [1]Employees complain executive only talk and don't follow the environment program enough, [2]External audit, [1]Insufficient training system, [4]Customers only, [5]Communication only by way of web site.

Data from environmental reports by U.S. and Japanese firms (Continued)

Table 5 A: United States Electric Companies Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
**Ameren	3	3	3	3	3	3	3	1	1	1
**AmericanElectricPower	3	3	3	3	3	3	3	3	3	[3]1
*Consolidated Edison	3	3	3	3	3	3	3	3	3	3
Entergy	3	3	3	3	3	3	3	1	1	[3]1
*Exelon	3	3	3	3	3	3	3	3	3	[3]1
**Firstenergy	3	1	1	1	1	1	1	1	1	1
Xcel Energy Inc.	3	[1]3	3	3	3	3	3	3	3	1
PG&E	3	3	3	3	3	3	3	[2]3	[2]3	1
Duke	3	3	3	3	3	3	3	1	1	1
TXU	3	3	3	3	3	3	3	1	1	1
Average Scores	**3**	**2.7**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**1.8**	**1.8**	**1**

*Detailed report, **Brief report, [1]Briefly mentioned, [2]Detailed information, [3]ISO 14001 equivalent system.

Table 5 B: Japanese Electric Companies Environmental Report Results

Companies	Environmental Indicator Checklist									
	Exec	RM	EMS	Improv.	Training	Stakehldr	Comm Ed.	Liability	Fines	ISO 14001
*Tokyo Electric	3	3	3	3	3	3	[3]3	3	3	3
*Kansai Electric	3	3	3	3	[1]3	3	3	3	3	3
*Chubu Electric	3	3	3	3	3	3	3	3	3	[4]2
*Chugoku	3	3	3	3	[2]3	3	3	1	1	[5]1
Hokuriku	3	3	3	3	3	3	3	3	3	[5]1
Shikoku	3	3	3	3	3	3	3	1	1	[6]2
Tohoku	3	3	3	3	3	1	3	1	1	3
**Hokkaido	3	1	2	2	3	1	3	1	1	2
Kyushu Electric	3	3	3	3	3	3	3	3	1	[7]2
**Okinawa Electric	3	3	3	3	1	1	3	1	1	3
Average Scores	**3**	**2.8**	**2.9**	**2.9**	**2.7**	**2.4**	**3**	**2**	**1.8**	**2.2**

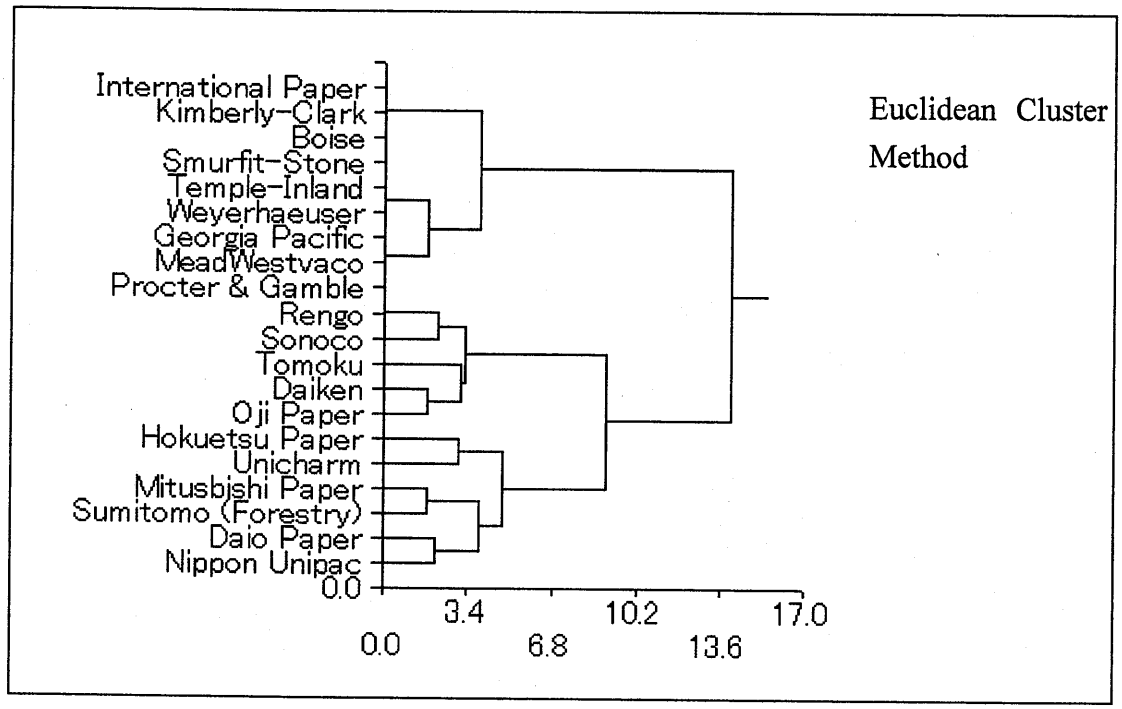
*Detailed report, **Brief report, [1]Few participants, [2]Green trainers program, [3]Several meeting held,

[4]82% ISO certified, [5]ISO equivalent, [6]Nuclear power plants and two oil burning plants ISO 14001 certified,

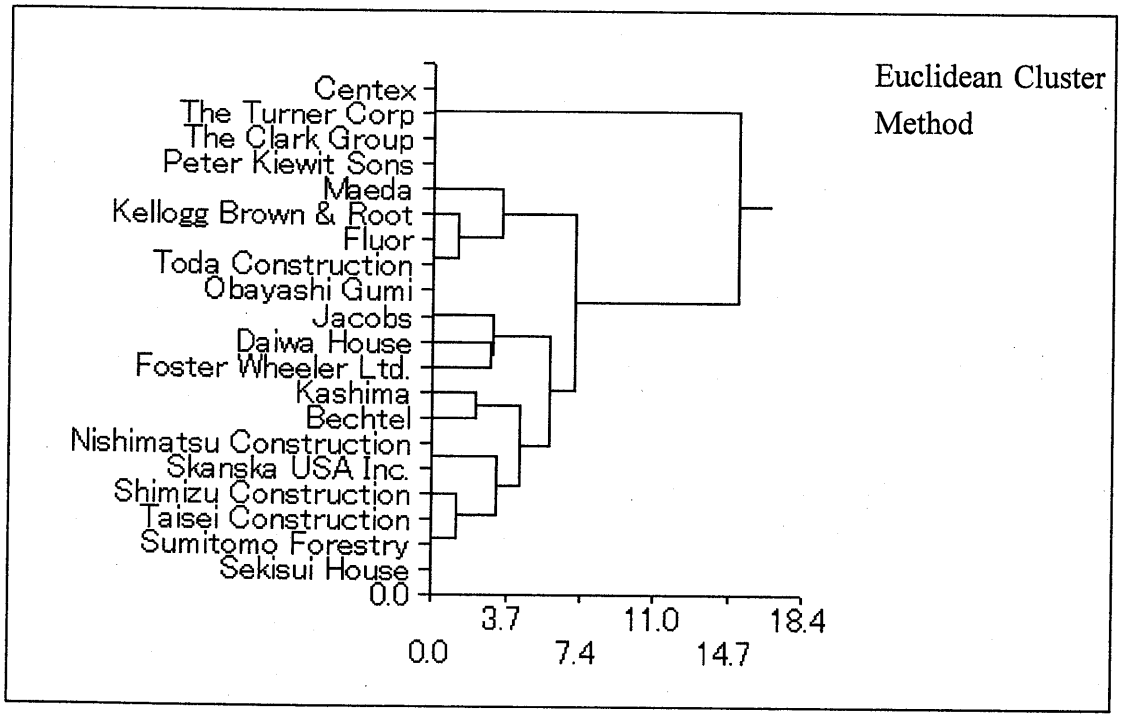
[7]Only one model branch ISO 14001 certified.

Data from environmental reports by U.S. and Japanese firms (Continued)

Euclidean Cluster for U.S. and Japanese Paper and Pulp Companies

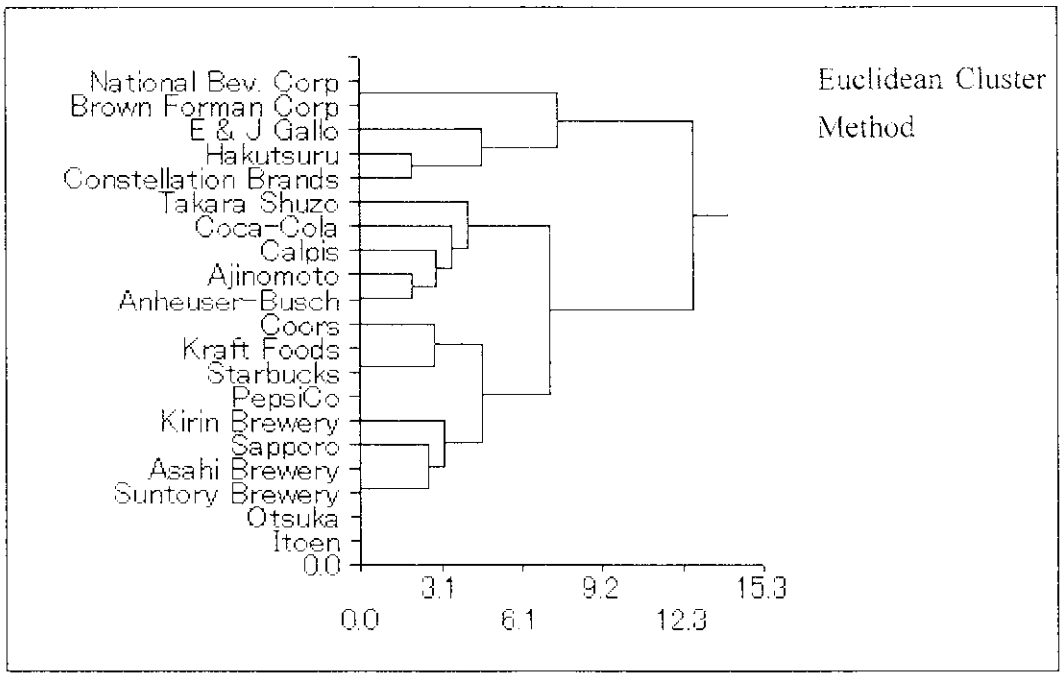


Euclidean Cluster for U.S. and Japanese Construction Companies



Data from environmental reports by U.S. and Japanese firms (Continued)

Euclidean Cluster for U.S. and Japanese Beverage Companies



WEB REFERENCES

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Georgia Pacific: http://www.gp.com/csrr/environment/purpose.html

Weyerhaeuser: http://www.weyerhaeuser.com/environment/sustainability/webreport/pdf/2005_SustainabilityReport.pdf

Kimberly-Clark: http://www.kimberly-clark.com/aboutus/kccorpenvirreport02.pdf

Procter & Gamble: http://www.pg.com/company/our_commitment/sustainability.jhtml

Smurfit-Stone: http://www.smurfit.com:8080/content/Safety/Stewardship/

Boise: http://www.bc.com/environment/index.jsp

Mead Westvaco: http://www.meadwestvaco.com/sustainability.nsf/v/Environmental_Performance

Sonoco: http://www.sonoco.com/ar2005/images/sonoco03_2003_ar.pdf

Nippon Unipac: http://www.np-g.com/e/csr/report/index.html

Oji Paper: http://www.ojipaper.co.jp/english/sustainability/e_report/index.html

Daio Paper: http://www.daio-paper.co.jp/environment/index.html

Rengo: http://www.rengo.co.jp/financial/pdf/2002_english.pdf

Sumitomo: http://www.sumitomocorp.co.jp/chikyu/e-report/manage.htm

Mitsubishi Paper: http://www.e-mpm.com/env

Unicharm: http://www.unicharm.co.jp/english/ir/index.html

Daiken: http://www.daikin.com/environment/report2005.html

Tomoku: http://www.tomoku.co.jp/english/environment/index.html

Hokuetsu Paper: http://www.hokuetsu-paper.co.jp/kankyo05_en.html

Chemical Industry

Dow Chemical: http://www.dow.com/commitments/stewardship/

Dupont: http://www.dupont.com/corp/social/SHE/index.html

ExxonMobil: http://www.exxonmobil.com/Corporate/Citizenship/CCR5/environmental_performance.asp

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PPG Industries: http://corporateportal.ppg.com/NA/CORP/EHS/

Equistar Chemical: http://www.lyondell.com/html/social/hse_policy.shtml

Air Products: http://www.airproducts.com/Responsibility/EHS/default.htm

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Sumitomo: http://www.sumitomo-chem.co.jp/english/responsible/index.html

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Construction Industry

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Kellogg Brown & Root: http://www.halliburton.com/about/hse.jsp

The Clark Group:	http://www.ajclarkgroup.co.uk/health_safety.htm
Foster Wheeler:	http://www.fwc.com/publications/pdf/HSE.pdf
Jacobs:	http://www.jacobs.com/markets/index.asp?market=Environmental%20Programs
Kashima:	http://www.kajima.co.jp/ir/annual/2004/environmental-initiatives.html
Taisei Const:	http://www.taisei.co.jp/english/environment/index.html
Shimizu Const:	http://www.shimz.co.jp/english/environment/index.html
Obayashi Const:	http://www.obayashi.co.jp/envandsoc/index.html
Sekisui House:	http://www.sekisuihouse.co.jp/company/data/current_report-71-datafile.pdf
Daiwa House:	http://www.daiwahouse.com/English/groupbrand/ar/index.html
Sumitomo Forest:	http://sfc.jp/information/kankyo/
Toda Const:	http://www.toda.co.jp/english/c02-02-5.html
Maeda:	http://www.maeda.co.jp/service/shisan/soil/index.html
Nishimatsu Const:	http://www.nishimatsu.co.jp/eng/env2001e/index.html

Beverage Industry

Anheuser-Busch:	[illegible]
Brown Forman:	http://ccbn.mobular.net/ccbn/7/1847/2035/
Coca Cola:	[illegible]
Constellation Brands:	http://www.cbrands.com/CBI/images/2006AnnualReport.pdf
Coors:	http://www.coors.com/part_environment.asp
E&J Gallo:	http://www.gallo.com/CAE/
Kraft Foods:	[illegible]
PepsiCo:	[illegible]
Starbucks:	http://www.starbucks.com/aboutus/StarbucksEnvironmentalFactSheetFeb04.pdf
Ajinomoto:	[illegible]
Asahi:	[illegible]
Calpis:	[illegible]
Hakutsuru:	[illegible]
Itoen:	[illegible]
Kirin Brewery:	[illegible]
Otsuka:	[illegible]
Sapporo Brewery:	[illegible]
Suntory:	[illegible]
Takara Shuzo:	[illegible]

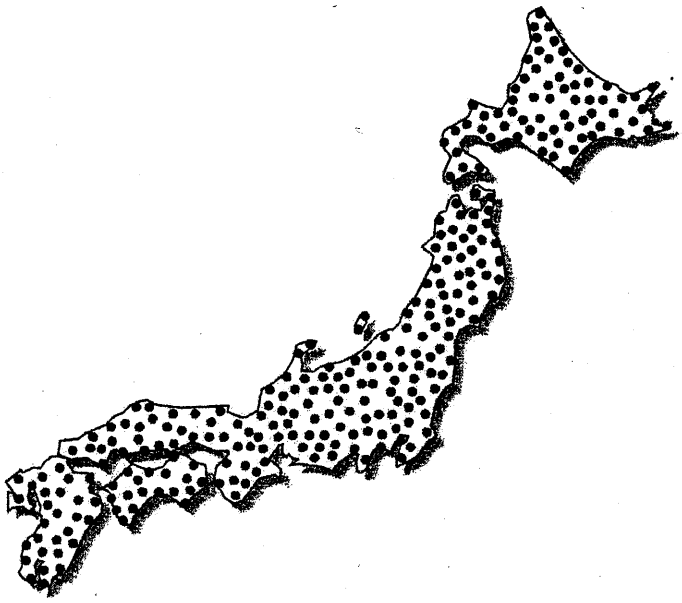
Electric Industry

Ameren:	http: www.ameren.com
AmericanElectric:	http. www.aep.com environmental default.htm
Con Edison:	http: /www.coned.com/ehs/
Entergy:	http: /www.entergy.com/our_community/environment.aspx
Exelon:	http: /www.exeloncorp.com aboutus/environment/
Firstenergy:	http: www.firstenergycorp.com environmental index.html
XcelEnergy Inc.:	[illegible]
	1-1-1_27620-10637-0_0_0-0.00.html
Duke Energy:	http: /www.duke-energy.com environment
TXU Energy:	http://www.txucorp.com/responsibility/environment/default.aspx
Tokyo Electric:	http://www.tepco.co.jp/eco/report index-j.html
Kansai Electric:	http: /www.kepco.co.jp corporate csr
Chubu Electric:	http: www.chuden.co.jp corpo csr index.html
Chugoku Electric:	http: www.energia.co.jp csr index.html
Hokuriku Electric:	http: www.hdk.co.jp japanese ems_j ems000_j.htm
Shikoku Electric:	http://www.yonden.co.jp/environ index.html
Tohoku Electric:	http://www.tohoku-epco.co.jp/enviro/index.html
Hokkaido Electric:	http: /www.hepco.co.jp english kankyou index.html
Kyushu Electric:	http: www1.kyuden.co.jp environment index
Okinawa Electric:	http: www.okiden.co.jp environment index.html

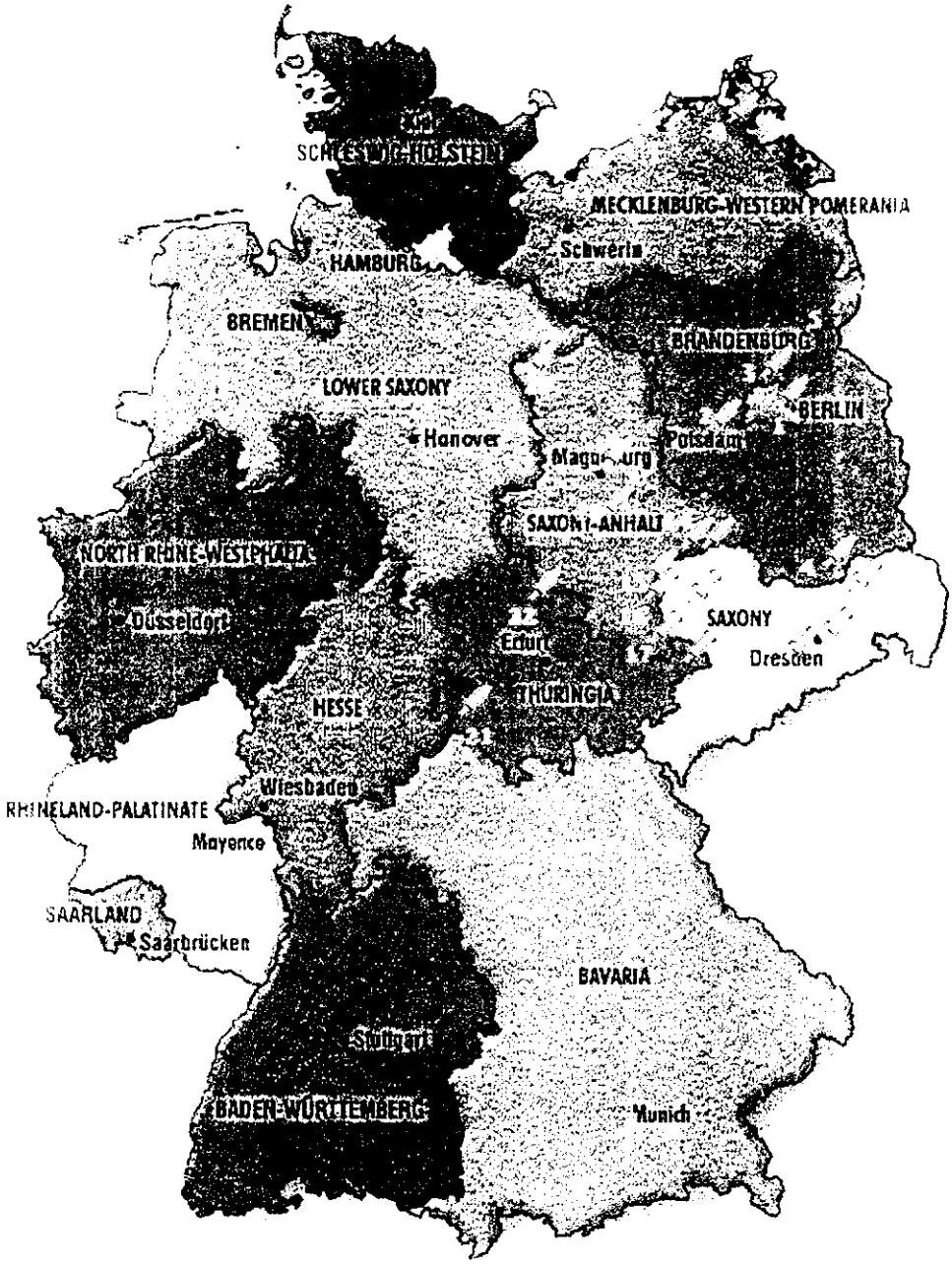
APPENDIX III

Areas of soil contamination in Japan, Germany and the United States

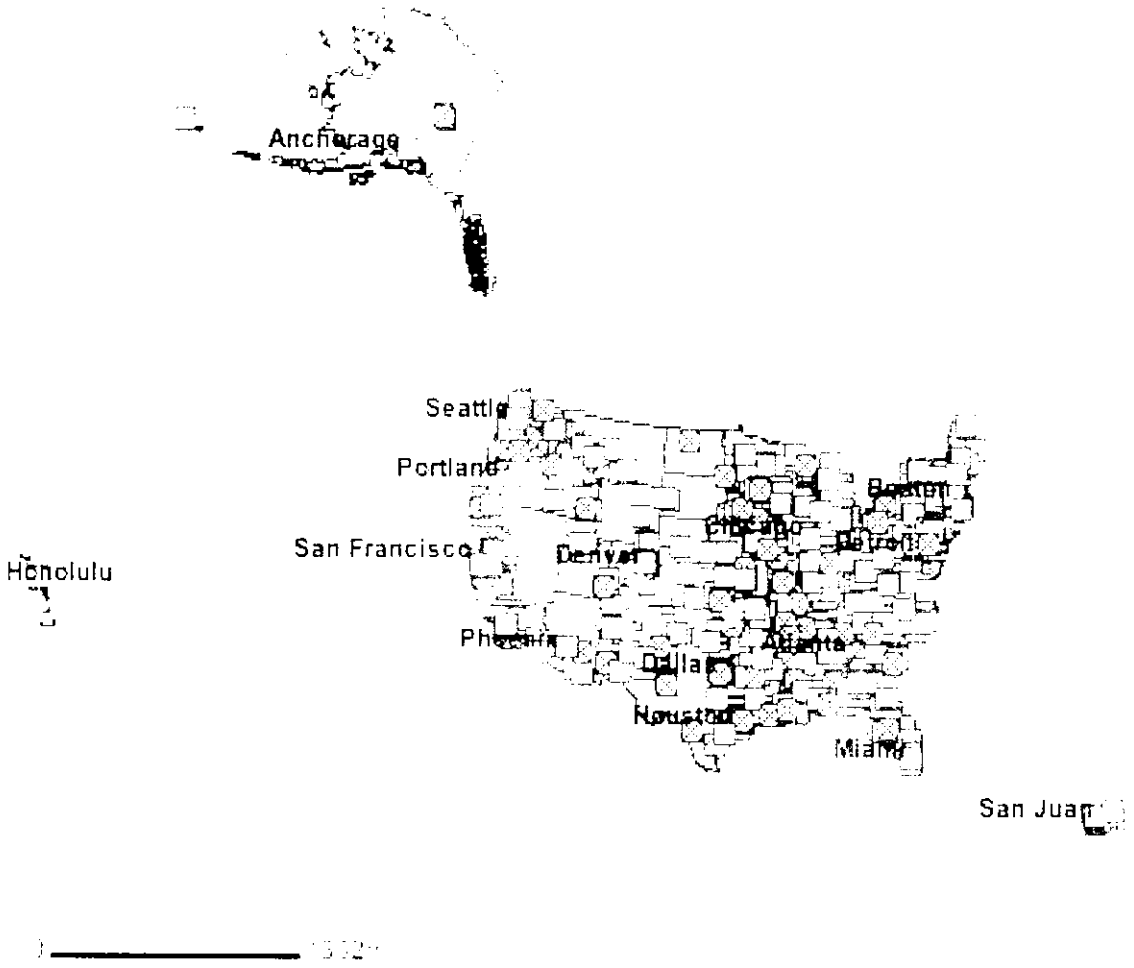
Estimation of Soil Contamination in Japan (Map: Center for Soil Environment)



Major Soil Remediation Sites in Germany (Federal Environmental Agency)



Superfund Sites in the United States (completed and in progress) (Toxmap)



Boxes with an X refer to Superfund sites that have finished remediation construction. Unmarked boxes refer to identified hazardous sites currently under remediation or waiting to undergo treatment.

APPENDIX IV

RESEARCH PUBLICATIONS

1) In Search of New Risk Management Strategies Using a Comparative Evaluation of Environmental Laws for Soil Contamination in the United States, Germany and Japan, 2004 IEEE International Engineering Management Conference Volume 1, Hall, W. Michael, Miyaji, Kousuke, October 2004

2) The Significance of Environmental Risk Management Strategies for Soil Contamination by Corporations, Miyaji, Kousuke, Hall W. Michael, March 2005 (Journal)

3) Comparative Study of Leading U.S. and Japanese Firms Risk Management Policies: In Search of New Risk Management Strategies, National Association of Environmental Professionals 30th Annual Conference Alexandria, Hall W. Michael, Miyaji, Kousuke, April 2005