Format for submitting pursuant to Article 8 of the Stockholm Convention the information specified in Annex E of the Convention

Introductory information	
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Chemical name	**Lindane**
Date of submission	**January 27, 2006**

(a) Sources, including as appropriate (provide summary information and relevant references)	
(i) Production data:	Lindane was produced in the United States. However, official records are sparse to non-existent, as production occurred 40-50 years ago. Romania produces the lindane for the agricultural products used in the United States. (CEC, 2005) Rhone-Poulenc of France formerly supplied the phamaceutical grade of lindane to the U.S. It is uncertain where any new stocks of phamaceutical grade lindane are produced for the U.S.
(ii) Uses	Agricultural uses. Lindane is currently registered in the United States in agriculture as a pre-plant seed treatment for barley, corn, oats, rye, sorghum and wheat. EPA regulates the agricultural uses of lindane. Up to 106 metric tons of lindane active ingredient are used annually, with an average of 64.5 metric tons used. (CEC, 2005) Lindane was first registered in 1947. Over time, 286 companies have registered more than 949 products on 263 use sites to control 200+ pest species. (Edwards, 2005) Pharmaceutical uses. Lindane is also registered as a pharmaceutical for human lice and scabies treatment. Less than one metric ton is used annually for these pharmaceutical uses. (CEC, 2005) The U. S. Food and Drug (FDA) regulates the pharmaceutical uses of lindane. In 2003 FDA issued a public health advisory concerning the topical use of lindane products for the treatment of lice & scabies. (FDA, 2003)
(iii) Releases:	Based on 2002 EPA Toxic Release Inventory Data reported in 2004, facilities in 19 states reported activities related to hexachlorocyclohexane. Ten facilities reported releases for a total 231 pounds of lindane, including 11 pounds in air, 177 pounds on land, 43 pounds other. For the 231 pounds, 103 were disposed off-site and 128 were released on-site. (EPA, 2006a)
Other	Superfund, administered by USEPA, is the government program to clean up uncontrolled hazardous waste sites in the United States. The following information is available for lindane and its isomers as contaminants of concern on the final National Priorities List: for lindane or the gamma isomer, there are 22 sites in 13 states; for the alpha isomer there are 24 sites in 14 states; for the beta isomer, there are 22 sites in 15 states; and for the delta isomer, there are 13 sites in 12 states. These sites are typically manufacturing, processing, or disposal sites where lindane and its isomers were selected as contaminants of concern. Contaminants of concern may be selected because of their intrinsic toxicological properties, because they are present in large quantities, or because they are presently in or potentially may move into critical exposure pathways. (USEPA, 2006b) http://www.epa.gov/superfund/sites/npl/index.htm

(b) Hazard assessment for endpoints of concern, including consideration of toxicological interactions involving multiple chemicals (provide summary information and relevant references)
The USEPA environmental risk assessment for lindane is on the internet. (USEPA, 2002a) See page 12 for the ecological toxicity endpoints for lindane. http://www.epa.gov/oppsrrd1/reregistration/lindane/efed_ra_revised.pdf The USEPA human health risk assessment for lindane is on the internet. (USEPA, 2002b) See page 16 for the exposure scenario, dose and endpoints. http://www.epa.gov/oppsrrd1/reregistration/lindane/009001_3.red.PDF The Agency for Toxic Substances and Disease Registry, part of U.S. Health and Human Services, updated its Toxicological Profile for HCH in late 2005. (ATSDR, 2005) It contains extensive information, especially on the health effects of all HCH isomers. http://www.atsdr.cdc.gov/toxprofiles/tp43.html The United States Library of Medicine maintains TOXNET, fully searchable databases on toxicology, hazardous chemicals, environmental health and toxic releases. http://toxnet.nlm.nih.gov/cgi-bin/sis/search WHO/Europe identified reference toxicological values for lindane in Health Risks of POPs from Long-Range Transboundary Air Pollution. (WHO, 2003). http://www.euro.who.int/Document/e78963.pdf

(c) Environmental fate (provide summary information and relevant references)	
Chemical/physical properties	No supplemental information to add.
Persistence	Lindane is persistent and moderately mobile. EPA estimates the soil half-life of 2.6 years. In water, it is stable to hydrolysis at pH 5 and 7 and its half-life of from 43-53 days at pH 9. Lindane degrades slowly by microbial action. (EPA, 2002a)
How are chemical/physical properties and persistence linked to environmental transport, transfer within and between environmental compartments, degradation and transformation to other chemicals?	For the requested additional information on the isomerization of the gamma isomer of HCH to the alpha and beta isomers, please refer to page 5 of this submission. For detailed information on transformation and degradation of lindane and other HCH isomers in air, water, sediment and soil, see section 6.3.2 in ATSDR, 2005. http://www.atsdr.cdc.gov/toxprofiles/tp43.html
Bio-concentration or bio-accumulation factor, based on measured values (unless monitoring data are judged to meet this need)	Bioconcentration studies were conducted on with bluegill sunfish (*Lepomis macrochirus*) at nominal concentrations of 0.54ug/L of lindane for 28 days, followed by 14 days of depuration. Bioconcentration factors were 780 for fillet, 2500 for viscera, and 1400 for whole fish tissues. After the 14 days of depuration, 14C levels were reduced by 96% in fillet, 95% in viscera, and 85% in whole fish. (EPA, 2002a) Bioconcentration factors of lindane in different aquatic organisms such as mussels, Daphnia and fish were reported to range between 43 and 4240 on a wet weight basis; the mean BCF on a lipid basis was reported to be 11,000. (Geyer HJ et al, 1997)

(d) Monitoring data (provide summary information and relevant references)

Lindane and beta HCH were included in the Third National Report on Human Exposure to Environmental Chemicals. (CDC, 2005) For lindane in serum, all samples were below the level of detection. For beta-HCH in serum (ng/g of lipid), the level in the total population was 43.3; by age group, it was 8.44 in ages 12-19 and 46.2 in ages 20 and older; by gender, it was 29.2 in males, 54.5 in females; by race/ethnicity, it was 84.4 in Mexican Americans, 45.9 in non-Hispanic Blacks, and 33.5 in non-Hispanic Whites. The executive summary and full report are on the internet. The information on lindane and beta HCH is found on pages 313-316. http://www.cdc.gov/exposurereport/3rd/pdf/thirdreport.pdf

Lindane and its alpha, beta, and delta isomers were included in the U.S. EPA National Lake Fish Tissue Study to estimate the national distribution of selected residues in fish tissue from lakes and reservoirs in the lower 48 states. There were a total of 881 samples measured. For lindane, there were 59 hits (6.70%), ranging from 0.652-8.56 ppb. For alpha HCH, there were 13 hits (1.48%), ranging from 4.81-8.43 ppb. For beta-HCH, there were 77 hits (8.74%), ranging from 1.162-38.8 ppb. For delta-HCH, there were 28 (3.18%) hits, ranging from 1.52-14.9 ppb. (EPA, 2006e) http://www.epa.gov/waterscience/fishstudy/

Lindane, alpha-HCH, and beta-HCH are monitored in air and precipitation in the Great Lakes region by the Integrated Atmospheric Deposition Network (IADN), operated cooperatively by US EPA-Great Lakes National Program Office and Environment Canada. (USEPA, 2006d) Average concentrations in the gas phase were: for alpha-HCH, 100-400 pg/m^3 in the early 1990s decreasing to 10-50 pg/m^3 since 2000; for lindane, 15-90 pg/m^3 in the early 90s decreasing to 5-30 pg/m^3 since 2000; for beta-HCH, very low, generally in the single or sub-single pg/m^3 range. Graphs of average annual gas-phase data can be found at: http://www.epa.gov/glnpo/glindicators/air/airb.html

Average concentrations in precipitation (volume-weighted mean) at seven main sites during the years 1997-2003 were: 470-890 pg/L for alpha-HCH, 690-1400 pg/L for lindane, and 160-650 pg/L for beta-HCH. (USEPA, 2006d) Lindane concentrations tend to be higher in the southern part of the Great Lakes basin, which is closer to agricultural activity, and peak in the late spring and early summer, after treated seeds are planted. Atmospheric loadings calculated with IADN data through 2000 show that loadings of lindane have remained similar or decreased somewhat throughout the 1990s (Blanchard et al. 2004). IADN loadings reports can be found at: http://www.epa.gov/glnpo/monitoring/air/iadn/iadn.html

Lindane is included in the U.S. EPA's Great Lakes Fish Monitoring Program (GLFMP). The concentration of Lindane in whole open water fish (Lake Trout and Walleye) have ranged between trace detection and .004 ppm between 1977 to 2000. The most recent available analytical data (2000) indicate that Lindane was only detected in whole lake trout from Lake superior at a concentration of .001 ppm. The concentration of Lindane in sport fish fillets (Chinook and Coho Salmon and Steelhead Trout) have ranged between trace detection and .005 ppm between 1982 and 2000. The most recent years of available analytical data indicated that Lindane was not detected in any GLFMP sport fish data. (USEPA, 2006c)

The National Oceanic and Atmospheric Administration's National Status and Trends (NS&T) Program has measured lindane (gamma-HCH) in the tissues of bivalves throughout the coastal US and Great Lakes from 1986 to present. (NOAA, 2006) In 1993, NS&T added lindane's alpha, beta, and delta isomers to its list of analytes. Over the Program's history, a total of 283 sites throughout the contiguous US, Alaska, Hawaii, and Puerto Rico have been sampled for this period of record, producing 1,383 records of measured alpha, beta, delta, isomer concentrations; and a total of 4,990 records for the gamma isomer. Median measured concentrations for alpha, beta, delta, and gamma were 0.34 (range: 0-18.7), 0.15 (range: 0-97.5), 0 (range: 0-16.7), and 0.56 range: (0-71.0) ng/g dry weight, respectively. A trends assessment using data pooled for the entire Nation indicates that there has been a statistically significant decline in lindane (Spearman Rho = -0.84, p=0.0002) from 1986 through 2003. Similar assessments performed for the remaining isomers suggest downward trends, though these were not statistically significant. These data can be downloaded at: http://ccma.nos.noaa.gov/cit/welcome.html.

(e) Exposure in local areas (provide summary information and relevant references)	
- as a result of long-range environmental transport	To gather background information for the North American Regional Action Plan for Lindane, the Commission for Environmental Cooperation sponsored a public meeting in Anchorage, Alaska, on February 11-12, 2004. There are several key presentations on the CEC web site, especially the following: John Vijgen, International HCH & Pesticides Association, on the environmental consequences of lindane production; Dr. Jay Van Oostdam, Health Canada, on the Canadian northern contaminants program; Dr. James Berner, Alaska Native Medical Center, on the traditional food safety biomonitoring program of pregnant native women and newborn infants in rural Alaska; and Dr. Terry Bidleman, Meteorological Service of Canada, on the transport of lindane and other HCH isomers through air and water. www.cec.org/programs_projects/pollutants_health/smoc/lindane.cfm?varlan=english

(f) National and international risk evaluations, assessments or profiles and labelling information and hazard classifications, as available (provide summary information and relevant references)

Toxicological Profile for Hexachlorocyclohexane, Agency for Toxic Substances and Disease Registry, US Department of Health and Human Services, updated in late 2005. http://www.atsdr.cdc.gov/toxprofiles/tp43.html

USEPA Reregistration Eligibility Decision (RED) for Lindane. 2002. See RED and supporting health and eco assessments included in the docket. http://www.epa.gov/oppsrrd1/REDs/lindane_red.pdf

North American Regional Action Plan (NARAP) on Lindane and other HCH Isomers. Public Comment draft. November 2005. http://www.cec.org/files/PDF/POLLUTANTS/Lindane-NARAP-Public-Comment_en.pdf

Health Risks of POPs from Long-Range Transboundary Air Pollution, WHO/Europe. 2003. Chapter 3 addresses HCHs. http://www.euro.who.int/Document/e78963.pdf

The United States Library of Medicine maintains TOXNET, fully searchable databases on toxicology, hazardous chemicals, environmental health and toxic releases. http://toxnet.nlm.nih.gov/cgi-bin/sis/search

Arctic Monitoring and Assessment Program, AMAP Assessment 2002. Persistent Organic Pollutants in the Arctic. This extensive report covers lindane and the other HCH isomers found in the Arctic. http://www.amap.no/

Arctic Monitoring and Assessment Program, AMAP Assessment. 2003. Human Health in the Arctic. http://www.amap.no/

(g) Status of the chemical under international conventions

Lindane is listed in Annex II of the LRTAP POPs Protocol. Attached below is the internet site for the 2004 assessment by Austria. http://www.unece.org/env/popsxg/docs/2004/Dossier_Lindane.pdf

Lindane and the HCH (mixed isomers) are listed in PIC. Decision Guidance Documents for the HCH Mixed isomers: http://www.pic.int/en/DGDs/HCHEN.doc
Lindane: http://www.pic.int/en/DGDs/LindaneEN.doc

Information on Possible Isomerization of Lindane to other Isomers

Oehme (1991) and Patton et al.(1989) have attributed the isomerization of lindane in contributing high concentrations of α-HCH in the Arctic. Several laboratory experiments have demonstrated the conversion of lindane to other isomers via photo-isomerization in air (Steinwander, 1976; Hamada et al., 1981; Malaiyandi and Shah,1984) and bio-isomerization in water, soil and sediments (Benezet et al.,1973; Huhnerfuss et al., 1992).

Walker et al., (1999) reviewed many laboratory and field studies to explore the potential of lindane conversion into other isomers and to corroborate with the spatial and temporal monitoring data of α- and γ- HCHs. They concluded that even though the laboratory data suggest lindane may transform into other isomers, air monitoring data do not support the evidence of significant isomerization of HCHs. Walker et al. (1999) noted that if photochemical transformation of γ-HCH to α-HCH in air takes place, one should see significant concentrations of α-HCH in the Southern Hemisphere air. A considerable reduction in α-HCH concentrations has observed recently in Arctic air (Shen et al., 2005 and Li et al., 1998).

Furthermore, Walker et al., (1999) note that reported concentrations of α-HCH in the air of southern Norwey dropped by 50% between 1991 to 1995 (Haugen et al., 1998), but no such pattern was observed for γ-HCH. Recent studies also indicated that bio-isomerization may play an insignificant role in the overall degradation of γ-HCH (Buser and Muller, 1995; Waliszewski 1993; Singh et al., 1991). Walker et al., (1999) concluded that there is no significant evidence of isomerization of lindane to contribute higher α-HCH concentrations in the environment.

Information on Existence of Stockpiles of Lindane and other HCH Isomers

Lindane was produced in the United States. However, official records are sparse to non-existent, as production occurred 40-50 years ago. (CEC, 2005) See section (a) (iii) for information on the Superfund sites where lindane and its other isomers have been identified as contaminants of concern.

See section (e) for information about the presentation Mr. John Vijgen, International HCH & Pesticides Association, made on the environmental consequences of lindane production at the CEC-sponsored workshop in Alaska in 2004. His presentation is on the internet at: www.cec.org/programs_projects/pollutants_health/smoc/lindane.cfm?varlan=english

Mr. Vijgen has also prepared a report on the Legacy of Lindane HCH Isomer Production. This report is on the internet at: www.ihpa.info/library_access.php

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