Annex F Questionnaire

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

Chemical name (as used by the POPS Review Committee (POPRC))

Chemical name: Alpha-hexachlorocyclohexane (alpha-HCH)
IUPAC name: (1a,2a,3b,4a,5b,6b)-Hexachlorocyclohexane
Common synonyms: 1,2,3,4,5,6-hexachlorocyclohexane, alpha isomer, (1alpha,2alpha,3beta,4alpha,5beta,6beta)-1,2,3,4,5,6-hexachlorocyclohexane, alpha-1,2,3,4,5,6-Hexachlorocyclohexane; alpha-benzene hexachloride, alpha-BHC, alpha-HCH, alpha-lindane; benzene-trans-hexachloride, Hexachlorocyclohexane-Alpha (Chemfinder, 2007)
CAS number: 319-84-6

Chemical name: Beta-hexachlorocyclohexane (beta-HCH)
IUPAC name: (1-alpha, 2-beta, 3-alpha, 4-beta, 5-alpha, 6-beta)-Hexachlorocyclohexane
Common synonyms: beta-1,2,3,4,5,6-Hexachlorocyclohexane; beta-Benzenehexachloride; beta-BHC, benzene-cis-hexachloride; beta-HCH; beta-Hexachlorocyclohexane; beta-Hexachlorocyclohexane; beta-isomer; beta-lindane; Hexachlorocyclohexane-Beta; trans-alpha-benzenehexachloride; beta-benzenehexachloride (Chemfinder, 2007)
CAS number: 319-85-7

Introductory information

Name of the submitting Party/observer

NGO Observer: Pesticide Action Network North America (PANNA) and Alaska Community Action on Toxics (ACAT), on behalf of the International POPs Elimination Network (IPEN)

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Date of submission
5 February 2008

A. Efficacy and efficiency of possible control measures in meeting risk reduction goals (provide summary information and relevant references):

HCH isomers Alpha-hexachlorocyclohexane (alpha-HCH) and Beta-hexachlorocyclohexane (beta-HCH) are a by-product of lindane (gamma-HCH) manufacture[1], as well as the manufacture of technical HCH. Technical HCH contains about 60-70% alpha-HCH, 5-12% beta-HCH and 10-15% gamma-HCH. The manufacture of 1 ton of lindane produces an average 9 tons of waste- a complex mixture of alpha-, beta- and delta-HCH.[2]

Historically alpha-HCH and beta-HCH were used as pesticides. Due to a ban on the use of HCH isomers in the 1970s in USA, Europe and Japan, their emissions decreased but peaked in the 1980s due to usage in Asian countries. After the 1980s, use figures dropped due to further prohibitions and restrictions.[3] Hence now lindane manufacture is the primary source of alpha-and beta- HCH isomers. To address the environmental issues associated with alpha-HCH and beta-HCH, the production of lindane would need to be halted, as this is the one significant source of these two isomers. The HCH isomers are also released into the environment from hazardous waste sites, stockpiles of lindane which are not controlled or maintained, and contaminated sites. These sources of the HCH isomers also need to be addressed to control the waste isomers.[4]

The POPRC requirements for the Annex F submission for the two HCH isomers are closely related to the Risk Profiles for alpha- and beta-HCH, and the Risk Profile and Risk Management Evaluation already completed for lindane. There is currently no independent production of alpha-HCH and beta-HCH or natural sources of these isomers outside of lindane manufacture. Hence the socio-economic considerations related to the withdrawal of alpha-HCH and beta-HCH, as requested in the Annex F submission on the two isomers, are actually linked to the fate of lindane.

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[1] Commission for Environmental Cooperation. Draft North American Regional Action Plan on Lindane and Other Hexachlorocyclohexane (HCH) Isomers. October 2005.
[2] Fact Sheet. Lindane's Dirty Secret: Indian Facilities Dump Toxic Waste. Compiled by Community Action for Pesticide Elimination as a project of the International POPs Elimination Network (IPEN) Pesticide Working Group. May 2005. (pp:6) http://www.panna.org/campaigns/docsLindane/lindaneDirtySecret.pdf.
[3] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9 http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf
[4] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9 http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf

Since formation of alpha- and beta-HCH is intimately tied to lindane production, their ultimate elimination requires a listing of lindane in Annex A without exemptions. This will ensure that alpha-HCH and beta-HCH will cease to be produced. Control measures for disposal of these waste isomers need to be taken, and have been described in the relevant section in this document. As the alpha- and beta-HCH isomers have no current significant uses, the socio-economic impacts of ceasing their production will be negligible. However, the cleanup issues surrounding their wastes will incur costs. The impacts of withdrawing lindane, the parent isomer in the production of alpha- and beta-HCH, have been outlined in the lindane Risk Management Evaluation.[5] We have reproduced some relevant parts of the Evaluation to highlight the interconnectivity of the fate of alpha- and beta-HCH with that of lindane.

(i) Describe possible control measures

Annex A listing: Alpha-HCH and beta-HCH should be listed in Annex A of the Stockholm Convention without exemptions. Alpha-HCH and beta-HCH have already been widely subjected to control measures similar to those outlined in Annex A of the Stockholm Convention: elimination of production, use, export, and import.[6] [7] Even though there is no known current intentional use of alpha-HCH or beta-HCH, they may still be produced or used in some countries. In addition, listing both isomers in Annex A without exemptions would prevent their re-introduction for intentional uses. The POPRC used this rationale to recommend listing of chlordecone in Annex A.[8] Finally, alpha-HCH, beta-HCH, and lindane should be listed together as a package in Annex A without exemptions to insure elimination of these three substances that the Committee has already determined warrant global action.

(ii) Technical feasibility

Alpha-HCH and beta-HCH are no longer used intentionally as pesticides indicating that technically feasible alternatives have already been substituted for them. Chemical and non-chemical alternatives for lindane are described in the Risk Management Evaluation.[9]

(iii) Costs, including environmental and health costs

As evidence that the environmental, social, and health costs of continued lindane production outweigh benefits, at least 52 countries have banned this persistent, toxic, and bioaccumulative pesticide.[10] Furthermore, the phase-out of the intentional uses of alpha-

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[5] Risk management evaluation on lindane UNEP/POPS/POPRC.3/20/Add.4
http://www.pops.int/documents/meetings/poprc/chem_review/Lindane/Lindane_RME_e.pdf

[6] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9
http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf

[7] Stockholm Convention on Persistent Organic Pollutants
http://www.pops.int/documents/convtext/convtext_en.pdf

[8] Risk management evaluation on chlordecone UNEP/POPS/POPRC.3/20/Add.2
http://www.pops.int/documents/meetings/poprc/chem_review/Chlordecone/Chlordecone_RME_e.pdf

[9] Risk management evaluation on lindane UNEP/POPS/POPRC.3/20/Add.4
http://www.pops.int/documents/meetings/poprc/chem_review/Lindane/Lindane_RME_e.pdf

[10] CEC, Commission for Environmental Cooperation. The North American Regional Action Plan (NARAP) on Lindane and other Hexacyclohexane (HCH) Isomers. November 2006. http://www.cec.org/lindane

HCH and beta-HCH has already occurred indicating that costs of alternatives have not inhibited their substitution.

Environmental costs:
Alpha- and beta-HCH are bioaccumulative, toxic, persistent and carried by long-range transport far from the site of manufacture. Hence any action that prohibits the production of these two isomers and requires cleanup of their wastes will have beneficial outcomes for the environment, with no negative environmental impacts due to their control. Some of the environmental costs of these isomers have been outlined in the beta-HCH Risk Profile.[11]

Health costs:
Alpha-HCH and beta-HCH have several human health impacts including suspected carcinogenicity, hepatic effects, neurological effects and reproductive effects.[12, 13] The alpha-HCH and beta-HCH Risk Profiles document effects in humans including neurophysiological and neuropsychological disorders and gastrointestinal disturbances; paraesthesia of the face and extremities, headache and giddiness, malaise, vomiting, tremors, apprehension, confusion, loss of sleep, impaired memory and loss of libido; higher alpha-HCH concentrations in women with uterine fibroids; higher alpha-HCH concentrations in children with aplastic anaemia; and a significant association between high beta-HCH concentrations in blood and breast cancer in pre-menopausal women. [14] [15]

B. Alternatives (products and processes) (provide summary information and relevant references)

(i) Describe alternatives

Since alpha-HCH and beta-HCH have no current intentional use and are only produced as a by-product of lindane or technical HCH manufacture, alternatives for these HCH isomers have already been substituted. Alternatives to lindane (gamma HCH) have been outlined in the Risk Management Evaluation.[16]

Non-chemical, agro-ecological methods can serve as alternatives to alpha-HCH and beta-HCH use as pesticides. These methods include preventative pest management through appropriate fertility and field sanitation practices that reduce pest pressure; the use and habitat enhancement of natural enemies; microbial preparations such as *Bacillus thuringiensis*; cultural practices such as crop rotation, intercropping, and trap cropping;

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[11] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9
http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf
[12] Draft risk profile on alpha hexachlorocyclohexane UNEP/POPS/POPRC.3/17
[13] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9
http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf
[14] Draft risk profile on alpha hexachlorocyclohexane UNEP/POPS/POPRC.3/17
[15] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9
http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf
[16] Risk management evaluation on lindane UNEP/POPS/POPRC.3/20/Add.4
http://www.pops.int/documents/meetings/poprc/chem_review/Lindane/Lindane_RME_e.pdf

barrier methods, such as screens, and bagging of fruit; use of traps such as pheromone and light traps to attract and kill insects.[17] These and other agro-ecological methods are being extensively and successfully practiced in many countries, eliminating the need for alpha-HCH, beta-HCH or other chemical interventions.

(ii) Technical feasibility

Since intentional use of alpha-HCH and beta-HCH appears to have ended, feasible alternatives for their use have already been implemented without cost implications. The technical feasibility of alternatives to lindane is covered in the lindane Risk Management Evaluation.[18] Non-chemical, agro-ecological methods are successfully practiced in many countries.

(iii) Costs, including environmental and health costs

Alternatives for alpha-HCH and beta-HCH have already been implemented without cost implications.

(iv) Efficacy

The apparent non-use of alpha-HCH and beta-HCH indicates that their substituted alternatives are efficacious.

(v) Availability

The existing commercial use of alternatives including non-chemical alternatives to intentional uses of alpha-HCH and beta-HCH indicates their commercial availability.

(vi) Accessibility

Alternatives to alpha-HCH and beta-HCH including non-chemical alternatives appear to be accessible and are already in commercial use.

C. Positive and/or negative impacts on society of implementing possible control measures (provide summary information and relevant references):

(i) Health, including public, environmental and occupational health

Elimination of alpha-HCH and beta-HCH through a listing in Annex A without exemptions would positively impact human health and the environment by decreasing and eventually eliminating emissions of substances that warrant global action.

The health impacts of alpha-HCH and beta-HCH have been described in their Risk Profiles.[19]

[17] Risk management evaluation on chlordecone, UNEP/POPS/POPRC.3/20/Add.2
http://www.pops.int/documents/meetings/poprc/chem_review/Chlordecone/Chlordecone_RME_e.pdf
[18] Risk management evaluation on lindane UNEP/POPS/POPRC.3/20/Add.4
http://www.pops.int/documents/meetings/poprc/chem_review/Lindane/Lindane_RME_e.pdf
[19] Draft risk profile on alpha hexachlorocyclohexane UNEP/POPS/POPRC.3/17
[19] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9

Withdrawal of the parent isomer gamma-HCH (lindane) will stop further production of alpha-HCH and beta-HCH, resulting in removal of the negative health impacts associated with exposure to alpha-HCH and beta-HCH.

Eliminating the production of lindane–and ensuring adequate cleanup of existing contaminated and waste sites containing alpha- and beta-HCH–is the only way to prevent sources of HCH contamination that cause unnecessary harm to the health of workers, local communities in proximity to production facilities, people being treated with unsafe lindane lice and scabies medications, vulnerable groups such as children and people with compromised immune systems, wildlife and people of the Arctic. Indigenous peoples in the Arctic are particularly vulnerable from dietary exposure to the alpha- and beta-HCH isomers through subsistence foods, such as caribou, fish, seal and whale. [20]

The (U.S.) Department of Health and Human Services (DHHS) has determined that HCH (all isomers) may reasonably be anticipated to cause cancer in humans. [21] The International Agency for Research on Cancer (IARC) has classified HCH (all isomers) as possibly carcinogenic to humans. The U.S. EPA has additionally classified technical HCH and alpha-HCH as probable human carcinogens, and beta-HCH as a possible human carcinogen.[22] Reproductive effects of HCH isomers during fetal development is of particular concern given the recent findings of the U.S. Centers for Disease Control and Prevention that more than half the participants in a national survey of chemicals in blood and urine carried beta-HCH in their blood, with the highest levels found among women of childbearing age.[23] [24] Beta-HCH has been described as producing estrogen-like effects through non-classical estrogen-dependent mechanisms of action.[25] [26]

EPA has also noted that lindane is "efficiently transmitted" from mother to child through breastmilk.[27] When women carry HCH isomers in their bodies, infants may be exposed to their damaging reproductive effects both inside and outside the womb.

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http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf

[20] ATSDR. 2005. Hexachlorocyclohexane Tox FAQs. http://www.atsdr.cdc.gov/tfacts43.html

[21] ATSDR. 2005. Hexachlorocyclohexane Tox FAQs. http://www.atsdr.cdc.gov/tfacts43.html

[22] Ibid.

[23] National Center for Environmental Health, U.S. Centers for Disease Control and Prevention, Second National Report on Human Exposures to Environmental Chemicals. January 2003; and Third National Report on Human Exposure to Environmental Chemicals. July 2005. Available at http://www.cdc.gov/exposurereport.

[24] Schafer, K.S. et.al. 2004. Chemical Trespass: Pesticides in Our Bodies and Corporate Accountability. Pesticide Action Network North America. Available at: www.panna.org

[25] Steinmetz, R., P. et.al. 1996. Novel estrogenic action of the pesticide residue beta-hexachlorocyclohexane in human breast cancer cells *Cancer Res*. 56, 5403-5409 in NARAP

[26] European Food Safety Authority. Opinion of the scientific panel on contaminants in the food chain on a request from the commission related to gamma HCH and other hexachlorocyclohexanes as undesirable substances in animal feed. *The EFSA Journal,* 2005 (250). Available at: http://www.efsa.europa.eu/etc/medialib/efsa/science/contam/contam_opinions/1039.Par.0003.File.dat/contam_op_ej250_hexachlorocyclohexanes_summary_en2.pdf

[27] EPA Memorandum: Lindane—Report of the FQPA Safety Factor Committee. August 2000: p 3.

The scientific literature regarding the cancer and non-cancer effects of HCH supports EPA's expressed concern that exposures to HCH isomers may be additive. HCH "mixed isomer" liver effects from chronic exposure include: increase in the enzymes lactate dehydrogenase, leucine aminopeptidase and gamma-glutamyl transpeptidase, as well as liver cell changes and induction of oxidative enzymes.[28]

(ii) Agriculture, including aquaculture and forestry

The alpha- and beta-HCH isomers have not been used in agriculture as pesticides since the 1980s. Hence banning lindane to prevent their production as a by-product will have no immediate negative impact on agriculture, and prohibition of further production and waste site cleanups could benefit agriculture by decreasing alpha-HCH and beta-HCH soil and water contamination.

(iii) Biota (biodiversity)

Controlling alpha-HCH and beta-HCH will be very beneficial for biota, as both isomers are bioaccumulative and persist in the environment, especially in colder climates.[29] HCH isomers are some of the most abundant and pervasive organochlorine contaminants found in the environment, especially in the Arctic. Of the two HCH isomers, beta-HCH bioaccumulates more strongly and is more resistant to metabolism and microbial degradation.[30] Beta-HCH is the most prominent isomer in human fat. HCH isomers can be measured in blood, urine, body fat, breast milk, and semen of exposed persons.[31] HCH has been shown to cross the placenta in pregnant women. HCH has been detected in human breast milk, suggesting that it can be transferred to infants from women who nurse.[32] Lindane and other HCH isomers can bio-accumulate easily in the food chain due to their high lipid solubility and can bio-concentrate rapidly in microorganisms, invertebrates, fish, birds and mammals, however, bio-transformation and elimination are relatively rapid when exposure is discontinued.[33]

The high levels of HCH isomers in the traditional food of the Arctic native peoples as well as in their blood and fatty tissue is a cause of concern.[34] The beta-HCH Risk Profile states that "…fairly high concentrations [of beta-HCH] in Arctic biota including marine mammals and birds were detected with increasing levels. Beta-HCH is present in terrestrial and aquatic food chain." "Beta- HCH may bioaccumulate and biomagnify in biota and Arctic food webs, especially in upper trophic levels."[35]

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[28] WHO Intergovernmental Programme on Chemical Safety (IPCS), Inchem. Hexachlorocyclohexane (Mixed Isomers). Accessed at http://www.inchem.org/documents/pims/chemical/pim257.htm#2.1%20Main%20risks%20and%20target%20organs. March 2006.

[29] Commission for Environmental Cooperation. Draft North American Regional Action Plan on Lindane and Other Hexachlorocyclohexane (HCH) Isomers. October 2005.

[30] Li, Y.F. et.al. 2002. The Transport of beta-hexachlorocyclohexane to the western Arctic Ocean: a contrast to alpha-HCH. *Sci. Total. Environ*, 291/1-3. :229-246. http://www.msc-smc.ec.gc.ca/data/gloperd/ArcticRes_e.cfm#TransBetaHCH

[31] ATSDR Tox FAQs, op.cit.

[32] ibid.

[33] World Health Organization (WHO). 1991. Lindane (Environmental Health Criteria 124). 208 pp. referenced in NARAP.

[34] POPRC. Beta-HCH draft Risk Profile, Op.cit.

[35] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9

Eliminating any further production of alpha- and beta-HCH isomers will ensure that the levels of HCH isomers found in biota, especially in the Arctic where these isomers reach by long-range transport, decreases over time, thus reducing the health impacts for humans and other mammals as well as the environmental impacts associated with exposure to these isomers.

(iv) Economic aspects

Since there are no current agricultural or other uses of alpha- and beta-HCH, there are no economic losses connected with the control measures for these isomers. Stopping lindane manufacture, the main source of production of these isomers, will have minimal negative economic impact, since there are effective alternatives for lindane in agricultural and pharmaceutical uses. These alternatives and their cost implications have been discussed in the lindane Risk Management Evaluation.[36]

The International HCH and Pesticide Forum, a collaborative effort of non-governmental organizations, governmental agencies, and industry, is a working group of experts with the goal of addressing the environmental problems caused by HCH/lindane production and the clean-up of former HCH/lindane production sites. Further information on this Forum can be found at www.hchforum.com/forumInfo.php. Data from this Forum states that the cost of cleaning up HCH wastes is US$2,000–3,000 per ton.

Society may incur some specific costs when alpha-HCH and beta-HCH wastes and contaminated sites are addressed. The Polluter Pays principle,[37] under which such costs should be internalized by the producer and/or the user, may be applied, but this is seldom done (at least without regulatory assistance). No good estimates are available of the potential cost recovery that can be achieved since the original 'polluter' often cannot be identified or is no longer in business. Nonetheless, the Polluter Pays Principle may be applied to legacy problems if the original 'polluter' can be identified and if a Party's regulatory framework permits.

(v) Movement towards sustainable development

Reduction and elimination of alpha-HCH and beta-HCH is consistent with sustainable development plans that seek to reduce emissions of toxic chemicals. A relevant global plan is the Strategic Approach to International Chemicals Management (SAICM) that emerged from the World Summit on Sustainable Development.[38] Over 100 health and environment ministers agreed to the SAICM, which was adopted at a high-level meeting

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http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf

[36] Risk management evaluation on lindane UNEP/POPS/POPRC.3/20/Add.4 http://www.pops.int/documents/meetings/poprc/chem_review/Lindane/Lindane_RME_e.pdf

[37] Stockholm Convention Preamble: "Reaffirming Principle 16 of the Rio Declaration on Environment and Development which states that national authorities should endeavour to promote the internalization of environmental costs and the use of economic instruments, taking into account the approach that the polluter should, in principle, bear the cost of pollution, with due regard to the public interest and without distorting international trade and investment."

[38] http://www.chem.unep.ch/saicm/

in Dubai in February 2006.[39] SAICM makes the essential link between chemical safety, sustainable development, and poverty reduction.[40] The Global Plan of Action of SAICM contains specific measures to support risk reduction that include prioritizing safe and effective alternatives for persistent, bioaccumulative, and toxic substances. The Overarching Policy Strategy of SAICM includes POPs as a class of chemicals to be prioritized for halting production and use and substitution with safer substitutes.

(vi) Social costs

By implementing control measures for lindane to reduce exposure to all HCH isomers, direct human and environmental exposure to alpha- and beta-HCH will be reduced and bioaccumulation and biomagnification will also reduce over time. This will be beneficial for particularly vulnerable populations in society such as nursing infants, the aged and women of childbearing age. The human immune system is sensitive to exposure to lindane at all dose levels. [41] Hence the withdrawal of lindane and consequent control of alpha- and beta-HCH isomers will also have a positive impact for vulnerable groups with compromised immune systems like HIV positive adults worldwide.

HCH isomer control and waste management measures will also be beneficial for the Arctic native peoples by reducing contamination of their traditional foods. The Alaska Traditional Diet Project (March 2004) found "substantial reliance on many subsistence foods such as fish, terrestrial mammals, marine mammals, and wild plants." Alaskan Native peoples rely on traditional foods because of cultural importance, availability, preferences in taste and nutrition to store-bought foods.[42] Significant levels of HCH isomers have been found in the traditional foods of the Arctic native peoples. Any steps taken to reduce exposure of Arctic native peoples to alpha- and beta-HCH will have beneficial social outcomes, since their traditional foods are an integral part of their social and cultural identity.

Withdrawal of pharmaceutical uses of lindane will help control the alpha- and beta-HCH isomers by completing the prohibition of lindane manufacturing. The withdrawal of pharmaceutical use of lindane will have additional positive social impacts such as reduction in potential long-term health effects associated with lindane use for lice and scabies control. [43] This also has added social and environmental benefits of reduction in lindane and HCH isomer water pollution from lice shampoo use. A report on the ban on pharmaceutical uses of lindane in California in the U.S. shows that the social costs resulting from the ban on lindane lice and scabies products has been negligible, with health professional adjusting quickly to the use of more effective alternative treatments. The report also shows that the levels of lindane leaving the Los Angeles County

[39] UNEP Press Release, New Global Chemicals Strategy Given Green Light by Governments, 7 February 2006 http://www.chem.unep.ch/saicm/iccm_sec.htm
[40] SAICM. http://www.chem.unep.ch/saicm/SAICM%20texts/SAICM%20documents.htm
[41] Rother, H. 2007. Lindane: Socio-Economic Impacts of Control Measures for South Africa. University of Cape Town, South Africa.
[42] Ballew,C. et.al. 2004. Final Report on the Alaska Traditional Diet Survey. The Alaska Native Health Board, Alaska Native Epidemiology Center.
[43] Rother, 2007. Op cit.

Sanitation District was reduced from a maximum of 340 ppt to 4 ppt.[44] This had very beneficial consequences for the water quality in the area and cost of treatment. A lindane pharmaceutical ban will also protect vulnerable populations like young children from exposure to lindane and the alpha- and beta-HCH isomers. Hence withdrawal of lindane pharmaceutical uses will not only control alpha- and beta- HCH isomers, but additionally prevent contamination of the environment and human health from all three HCH isomers- alpha-, beta- and gamma-HCH.

The fact that the social costs of transitioning from lindane to alternatives will be minimal is evidenced in the experiences of the more than 50 countries that have already successfully made the transition to alternatives. The California experience following a ban of lindane shampoos and lotions specifically demonstrates the negligible impact of a transition from pharmaceutical uses of lindane.

D. Waste and disposal implications (in particular, obsolete stocks of pesticides and clean-up of contaminated sites) (provide summary information and relevant references):

A listing of alpha-HCH and beta-HCH in Annex A would subject them to Article 6 of the Stockholm Convention and require that they be disposed, "…in a safe, efficient and environmentally sound manner."[45]

(i) Technical feasibility

For every ton of lindane that is produced, there are 6–10 metric tons of other HCH isomers, including alpha-HCH and beta -HCH that must be disposed of or otherwise managed. By one estimate there are 2–4 million tons of HCH isomer waste worldwide.[46] Ceasing the production of lindane would prevent additional environmental, social, health and economic costs of lindane and the other HCH isomers. Of particular concern, in addition to the gamma-isomer (lindane), are the alpha- and beta-isomers of HCH.

There have been attempts to re-use the HCH isomers produced as a result of the production of lindane for producing other chemicals such as trichlorobenzene. This was an early method that has been largely discontinued since the 1970s.

Biodegradation of HCH isomers is another waste management option that has been found through experimental studies. These two control options are discussed in this document.

In the United States, there were formerly several producers of lindane. These have not been active since the 1970s, but HCH waste, predominantly alpha and beta isomers, still

[44] Heil, A.T.2006. California's Pharmaceutical Lindane Ban. Sanitation Districts of Los Angeles County. http://www.panna.org/docsLindane/annheil3.pdf
[45] Stockholm Convention on Persistent Organic Pollutants, Article 6 http://www.pops.int/documents/convtext/convtext_en.pdf
[46] Fitzgerald, T. 2006. A Pesticide's Toxic Legacy. *Trio* 2005 Fall. http://www.cec.org/trio/stories/index.cfm?ed=16&ID=178&varlan=english

remains in several areas. About 65,000 tons of HCH wastes exist in the US.[47] Some of the former lindane production sites in the US are now designated as Superfund sites by the U.S. Environmental Protection Agency (EPA), meaning that they are uncontrolled or abandoned places where hazardous waste is located, possibly affecting local ecosystems or people. According to the EPA, there are Superfund sites contaminated with lindane in the U.S. states of Delaware, Pennsylvania, North Carolina, Georgia, Alabama, Florida, New Jersey, Oregon, Missouri, California, Puerto Rico, Tennessee, Texas, Michigan and Washington.[48]

Stockpiles of pharmaceutical grade lindane are present in the U.S. and are being utilized for the production of lice and scabies control products. These will need to be disposed in a sustainable manner in the event of pharmaceutical uses of lindane being nationally banned in the U.S. The state of California has already banned pharmaceutical uses of lindane.

Chemical Disposal methods for Lindane and HCH Isomers:

The International HCH and Pesticides Forum (IHPF) has the following to say about HCH isomers being re-used for production of alternate chemicals:

"There have been attempts to re-use the inactive isomers, and this has led to the formation of 1,2,4-trichlorobenzene (75%), which from 1954 and onwards formed the basis for the production of 2,4,5-trichlorophenoxyacetic acid (2-4-5-T) and from 1969 and onwards for the manufacturing of 2,5-Dichloro-4-bromphenol-oxyphosphoric acid (insecticide Bromophos)…A number of the Lindane manufacturers have dehydrohalogenated the inactive isomers by heating and catalysis. This leads to total dehydrohalogenation of HCH under formation of trichlorobenzene, the 1,2,4-isomer (60-66%), 1,2,3-isomer (32-38% and 1,3,5-isomer (ca. 2%) and chlorhydric acid (HCl). The mechanism of this elimination is such that all isomers have more or less the same elimination rate; the difference is no more than a factor 3. There is one exception, however and that is the beta-isomer, which reacts about 7000 times more slowly than the others. This is caused by the specific configuration of beta-HCH. Care must therefore be taken that all beta-HCH is completely dehydrohalogenated. The trichlorobenzene is purified by distillation. In the 1980s it was still a valuable raw material for many other organic chemicals…When the Vietnam war ended the market for 2,4,5-T collapsed…Most of the described methods have been given up very early and no appropriate application or ingenuous use for the residuals has been found… Consequently, most of the waste products have been dumped over the last 50 years."[49]

[47] Ibid.
[48] Ibid.
[49] Vijgen, J. 2006. The Legacy of Lindane HCH Isomer Production. International HCH and Pesticides Association. www.milieukontakt.nl/file.php?table_name=activity&id=311&field_name=documentation_1_file

The following extract is taken from Annex II of the report by John Vijgen on Lindane and HCH isomers, which is submitted by reference (see below).[50] As per Vijgen, these are some of the chemical methods used to dispose lindane and other HCH isomers.

1. **Germany**
In Germany two manufacturers have been able to eliminate HCH-residuals. In one case a total amount of 40 000 tons of HCH residuals has been completely used within a couple of years for the production of 1,24-trichlorobenzene (TCB) which was then in a thermal destruction converted to 1,2,4,5-tetrachlorobenzene and was chlorinated via trichlorophenol to 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). In the other case more than 30 000 tons have been converted to trichlorobenzene. The method was relatively simple, but very cost-intensive due to the high corrosion of the equipments used.

Continuous processes were possible. For the production of 1,2,4,4 tetrachlorobenzene, a trichlorobenzene with 75% 1,2,4 TCB brought an economical advantage. This was possible by means of the application of certain kind of active carbons. The HCl-separation took place on the granulated carbon at high temperature (sublimation). Problems occurred with the sales of the formed HCl, which only could achieve a marketable quality by means of costly adiabetical adsorption and application of active carbon as final polishing step. Therefore HCl was used in most of the manufacturers internally for neutralization purposes. The chlorination to 1,2,4,5-tetrachlorobenzene as pre-product for the 2,4,5-trichlorophenoxyacetic acid (2,4,5-T) brings again a high percentage of undesirable tetrachlorobenzene isomers and high chlorinated side-products (up to penta-and hexachlorobenzene) and these products could be used only seldom.

2. **France**
The following capacities were mentioned at the beginning of the 1990s: 36 000 t/y of HCH, 4 000 t/y of lindane, 16 400 t/y TCB and 12 000 t/y of HCl. During 1994, the last producer stopped the lindane production and the production of 1,24-TCB by its cracking. The pure 1,24-TCB was then produced by distillation by another company and sent back to be used as an intermediate in the synthesis of a pesticide by the manufacturer in a continuous process in a closed system.

3. **Russia**
The situation in Russia is described by Treger at the chemical plant “Khimudobrenij” at the town of Chapaevsk, between 1968 – 1971: “following the isolation of gamma-HCH (for 1 ton of gamma-isomer up to 10-12 tons of "intoxic" isomers were formed), processing of all other isomers was introduced at the industrial scale. The production stopped approximately in 1986-87.

The technological scheme was as follows:
1. Thermal (at 240-250°C), initiated with chlorine, dehydrochlorination of HCH isomers resulting in 1,2,4-trichlorobenzene (TCB) in the liquid phase and isolation of relatively small amount (up to 1 000 t per annum) of purified TCB.

[50] Vijgen, J. 2006. The Legacy of Lindane HCH Isomer Production- A Global Overview of Residue Management, Formulation and Disposal- Annex II. International HCH and Pesticides Association.

2. High temperature (up to 600°C) chlorination of TCB on charcoal resulting in the commercial hexachlorobenzene (HCB) – about 1 000 t per annum.
3. Water-alkali hydrolysis of HCB resulting in sodium pentachlorophenolate –annual capacity was 2 400 t."

This technological scheme was used during more than 15 years, up to end-80s, when all these production facilities, including the ones for HCH, were closed down. China and Russia still manufacture PCP from HCB by caustic soda hydrolysis, which utilizes the waste alpha-HCH from lindane manufacture.
This is believed to be the only current direct use of HCB as a chemical intermediate..

4. **Czech Republic**
Holoubek et al, report that a somewhat different approach, which was applied at the Spolana Factory (presently in the process of remediation). In the year 1965, a complex processing of HCH isomers was introduced according to technology developed by the research department of agrochemical technology in Bratislava. In the first phase, the isomers underwent dechlorination by caustic soda to trichlorobenzene (specifically a mixture of trichlorobenzene isomers), which was isolated from the reaction mixture by steam distillation. Trichlorobenzene was then processed by direct catalytic chlorination to a tetrachloro- and hexachlorobenzene (HCB) compound. Tetrachlorobenzene (TeCBz) due to the action of caustic soda was converted to sodium trichlorophenolate, which either by acidification was converted to trichlorophenol, or due to the action of chloroacetic acid to the sodium salt of 2,4,5- trichlorophenoxyacetic acid (2,4,5-T). The reaction of sodium salt of 2,4,5-T with butylalcohol produced the butylester of 2,4,5-T acid, which was the main active ingredient of arboricidal preparations ARBORICID E 50 and ARBORICID EC 50.

Sodium pentachlorophenolate was sold dried and in 7-11% water diluted solution forms. Pentachlorophenol was sold dried and as a xylene solution with a minimum 23% PeCP content. PeCP was equally used as one of the active ingredients in the combined insecticidal and fungicidal preparation PENTALIDOL for all types of wood treatment, constructions, banisters, furniture, flooring and roofing against wood-damaging pests, wood-damaging fungi and various types of moulds.

Due to the action of caustic soda, Tetrachlorobenzene (TCB) was converted to sodium trichlorophenolate, which either by acidification was converted to trichlorophenol, or due to the action of chloroacetic acid to the sodium salt of 2,4,5-trichlorophenoxyacetic acid (2,4,5-T). The reaction of sodium salt of 2,4,5-T with butylalcohol produced the butylester of 2,4,5-T acid, which was the main active ingredient of arboricidal preparations ARBORICID E 50 and ARBORICID EC 50. Non-reacted parent lyes were brought back to previous stages, which on one hand made this technology almost without waste, however on the other hand led to the concentrating of pollutants and reaction side products.

At the time when the technology of processing ballast HCH isomers was being implemented, it wasn't known that side reactions occur during the abovementioned syntheses with trace amounts of substances harmful to human health, causing liver necrosis and manifested externally by the presence of chloracne. Attention was called to the cause of this problem by the workers of the Chemical- Technical University in Pardubice, who from literature and then during in-person discussion abroad, were able to find out information about similar problems in Germany. There it was discovered, that during dehydrochlorination of HCH and during further processing of chlorinated derivatives of benzene, trace amounts of polychlorodibenzodioxins are created, among them even 2,3,7,8- tetrachlorodibenzo-p-dioxin (TCDD), which has the highest toxicity.

Landfills for disposal of soil contaminated with lindane and HCH:
This is another strategy used for disposal of lindane. The following extract from Vijgen (2006) describes two such cases of landfills in Spain and Netherlands.

"For more than forty years, technical HCH was produced by two companies located in the Basque Country in northern central Spain. Starting in 1953, Lindane was extracted from the technical HCH mixture, leaving behind huge amounts of waste HCH isomers. The authorities in the Basque Country have calculated that 82 000 tons of waste HCH isomers have been dumped at more than thirty sites in their region.

"Dumping of waste isomers stopped in 1987, when the Basque authorities banned this practice. Due to the mixing of waste HCH isomers with soils and other wastes, the authorities estimate that there are between 500 000 and 1 Mio tons of contaminated residues in their region. In addition to environmental problems and unacceptable risks to inhabitants this imposes, the contamination has also in the past, hindered important development projects in areas near the sites where the isomers were dumped.

"The authorities developed a strategy to manage the contamination. Over a period of 10 years they conducted inventories and constructed two secure hazardous waste landfills for the contaminated soils; one for 176 000 tons and the other for 480 000 tons of waste residues and contaminated soil. In addition, a process called the base catalyzed dechlorination (BCD) process was developed to treat 3 500 tons of HCH waste isomers…

"… there was high contamination of soil in the eastern region of Netherlands. At the end of the 1980s, the Dutch government authorized a large project to manage the regional contamination issue. In 1988, a temporary storage site was established on top of a former landfill site. About 200 000 tons of soil excavated from the most contaminated areas of the region, were stored at this site. At the time no adequate technology was available to treat soil contaminated with waste isomers, and the Dutch government invited companies to develop technologies to treat the isomers and investigated their efficiency. By the beginning of 2002, all waste isomers at the temporary storage site had been treated, and the site was capped, secured, and used by the farming community for summer festivals."[51]

[51] Ibid.

Biodegradation of HCH isomers- a possible solution for HCH contaminated sites:
A 2002 study was conducted to monitor the biodegradation of alpha-, beta-, gamma-, and delta-hexachlorocyclohexane (HCH) isomers in liquid culture by a bacteria of the Pandoraea species; and to determine the influence of pH and temperature on the biodegradation of alpha- and gamma-HCH in liquid as well as in soil slurry cultures. The results of this study suggest that this bacterial strain may effectively be used for remediating polluted sites and water contaminated with different HCH isomers over a range of environmental conditions. The Pandoraea species degraded 79.4% delta-HCH and 34.3% gamma-HCH in liquid culture at 4 weeks of incubation. Alpha- and beta-HCH exhibited almost identical rates (41.6 and 42.4%, respectively) of degradation. The highest degradation of alpha- and gamma-HCH (67.1 and 60.2%, respectively) was observed at an initial pH of 8.0 in liquid; 58.4 and 51.7% rates of degradation of alpha- and gamma-HCH, respectively, at an initial pH of 9.0 were found in soil slurry cultures. An incubation temperature of 30 degrees C was optimum for effective degradation of alpha- and gamma-HCH isomers (62.5 and 57.7%, respectively) in liquid culture, and 54.3 and 51.9% rates of degradation of alpha- and gamma-HCH isomers, respectively, were found in a soil slurry. Increasing the soil/water ratio decreased the extent of degradation of both HCH isomers. Degradation of HCH isomers occurred concomitant with bacterial growth. Byproducts of growth from Pandoraea species significantly decreased the pH of the liquid and the soil slurry during the growth on HCH isomers.[52]

In another study examining biodegradation for HCH contaminated sites, researchers isolated a bacterium Pseudomonas aeruginosa ITRC-5 that mediates the degradation of all the four major isomers of HCH under aerobic conditions, both in liquid-culture and contaminated soils. In liquid-culture, the degradation of alpha- and gamma-HCH was found to be rapid and was accompanied with the release of 5.6 micromole chloride ions and 4.1 micromole CO2 micromole(-1) HCH-isomer. The degradation of beta- and delta-isomers was slow, accompanied with the release of 0.9 micromole chloride ions micromole(-1) HCH-isomer, and resulted in a transient metabolite 2,3,4,5,6-pentachlorocyclohexan-1-ol. The strain ITRC-5 also mediated the degradation of alpha-, beta-, gamma-, and delta-isomers in contaminated soils, where degradation of otherwise persistent beta- and delta-HCH was enhanced several fold in the presence of alpha- or gamma-HCH. The degradation of soil-applied beta- and delta-HCH under aerobic conditions had not been reported earlier. The isolate ITRC-5 thus demonstrated potential for the bioremediation of HCH-wastes and contaminated soils. [53]

Alpha- and beta- HCH isomers are produced only as a result of the production of lindane or of the production of technical HCH. For each ton of lindane 8-12 tons of alpha- and beta-HCH isomers are produced. Hence halting lindane and technical HCH production would lead to stopping of the production of the HCH isomers. These isomers have ended mostly as hazardous wastes dumped without treatment in many places in the world.

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[52] Siddique T. et.al. 2002.Temperature and pH effects on biodegradation of hexachlorocyclohexane isomers in water and a soil slurry. *J Agric Food Chem.* Aug 28;50(18):5070-6
[53] Kumar, M. et.al. 2005 .Enhanced biodegradation of beta- and delta-hexachlorocyclohexane in the presence of alpha- and gamma-isomers in contaminated soils. *Environ Sci Technol.* 2005 Jun 1;39(11):4005-11

In the United States alone, over 65,000 tons of waste is estimated. Though there has been no active production of lindane in the United States since the 1970s, but HCH waste, predominantly alpha and beta isomers, still remains in several areas.
Cost: The cost of cleanup in the U.S. according to experts is roughly US$2,000–3,000 per ton.[54]

Vigjen[55] from the IHPF outlines some country efforts and costs in cleaning up HCH wastes:

In the Basque Country in northern central Spain, the authorities developed a strategy to manage the HCH isomer contamination. Over a period of 10 years they conducted inventories and constructed two secure hazardous waste landfills for the contaminated soils; one for 176,000 tons and the other for 480,000 tons of waste residues and contaminated soil. In addition, a process called the base catalyzed dechlorination (BCD) process was developed to treat 3,500 tons of HCH waste isomers.

Cost: The Basque Country Region of Spain spent over a decade and an estimated 50 mio EUR to build the two secure landfills for wastes and contaminated soils. Of that total amount 8.4 million EUR was spent on the base catalyzed dechlorination process.

In the Netherlands, a portion of the remaining waste HCH isomers in storage were illegally collected and mixed with soil for construction purposes and hence dumped at numerous locations. Approximately 290 sites have been identified in a predominantly agricultural area in the eastern region of the Netherlands. In 1974 there was a massive fish kill in a canal next to a site where some of the isomers were stored. This time incident resulted in public outcry and in 1975 the Dutch regional government put pressure on the new owners of the facility to pay for the complete removal of 4,000 tons of waste isomers. These were consequently shipped to Germany for disposal. In 1988, a temporary storage site was established on top of a former landfill site. About 200,000 tons of soil excavated from the most contaminated areas of the region, were stored at this site. By 2002, all waste isomers at the temporary storage site had been treated, and the site was capped and secured.

(ii) Costs

Cost: The Dutch government spent approximately 27 million EUR to clean up soil highly contaminated with waste HCH isomers in the eastern region of the Netherlands. Currently there are additionally 200,000 tons of less contaminated soils remaining that may need remediation in the future.

The revenues generated from the sale of lindane may be outweighed by costs associated with the clean up of waste isomers. If the waste HCH isomers had been promptly treated once produced, then contamination may have been minimized and the high costs of remediation and damage to the environment may have been avoided.

[54] Fitzgerald, T. 2006. Op.cit.
[55] Vijgen, J. 2006. Op.cit.

The examples above show that, if at least some containment measures would have been taken during production, large amounts of money could have been saved.

Although the exact the amounts of HCH-residuals are not known, a first estimate is in the range varying from 1.6-1.9 to 4.8 million tons worldwide. The extent of this problem is thereby far beyond present estimates on obsolete pesticides in Africa (55 000 tons) and in the Eastern European region (500 000 tons).[56]

According to a study by Quintero, J.C. et al., an anaerobic bioreactor allows the efficient degradation of HCH isomers in soil slurry. Alpha- and gamma-HCH were completely degraded after 10 days under optimum conditions, whereas a substantial decrease (nearly 90%) in beta- and delta-HCH was achieved only after 50 days of reactor operation. Based on the results related to the total degradation of the HCH isomers and the degradation rates, which were especially high for alpha- and gamma-HCH, the anaerobic slurry reactor appears to be a viable alternative for the degradation of HCH isomers in soil.[57]

Results from another study indicate that anaerobic degradation of (gr)a-, (gr)b-, (gr)g-, and (gr)d-hexachlorocyclohexane (HCH) by Sphingomonas paucimobilis results in complete degradation of (gr)a-HCH after three days of treatment. The authors discuss the implications of their finding for the management of pesticides and the treatment of contaminated waters and soils.[58]

Technical HCH was primarily used for the production of lindane. Technical HCH contains no more than 20% of lindane, which is purified and concentrated to 99%. To manage wastes, remaining isomers may be used to produce hydrochloride acid and trichlorobenzene by pyrolysis, or may be dehydrohalogenated to trichlorobenzene isomers. However, because trichlorobenzenes can also be obtained by other methods, this use of HCH was of limited application. No other products are made with technical HCH.[59]

E. Access to information and public education (provide summary information and relevant references):

The North America Regional Action Plan on Lindane and Other Hexachlorocyclohexane

[56] Ibid.

[57] Quintero, J.C et. al. May 2006. An Anaerobic Bioreactor Allows The Efficient Degradation Of HCH Isomers In Soil Slurry, Univ. of Santiago de Compostela, Spain. *Chemosphere* v 63 n 6, p 1005-1013, http://www.usc.es/biogrup/2006%20chemosphere%2063-1005-1013.pdf

[58] Johri, A. K. et. al. Sept 1998. Degradation Of Alpha, Beta, Gamma And Delta-Hexachlorocyclohexanes By Sphingomonas Paucimobilis, *Biotechnology Letters*, Vol 20 No 9, p 885(3)

[59] Assessments of Technological Developments for the Production and Use, Including Exemptions, of Substances Listed in Annexes I and II - Background Document, Submitted to the UNECE Convention on Long-range Transboundary Air Pollution Protocol on Persistent Organic Pollutants Task Force on POPs, June 2005 http://www.unece.org/env/popsxg/2005/Bkgd%20Doc%20S%20&%20E%20Review%20Annex%20I%20&%20II%20final.pdf

(HCH) Isomers (NARAP)[60] has laid out the following outreach and education steps for the parties of the North America Agreement on Environmental Cooperation (NAAEC), i.e. Canada, Mexico and United States of America. The focus of the steps is especially on lindane as the parent chemical for the production of alpha-HCH and beta-HCH.

Regarding lindane pharmaceutical uses:

"i) The Parties will strengthen outreach and education efforts to provide information on the possible risks associated with lindane and alternatives for the treatment of lice and scabies. Target groups may include but not be limited to:

- Local communities
- Educators
- Media
- Health care providers
- Medical associations
- NGOs and health consortia
- Indigenous and Tribal organizations

This may include exchanging information on cautionary labeling, development of fact sheets, other guidance documents, workshop proceedings etc.;

ii) The Parties are committed to sharing information regarding adverse events associated with lindane, new regulatory actions and education strategies in order to improve clinical practice standards in a harmonized way; and

iii) The Parties will ensure that all users including indigenous populations are suitably advised in a culturally acceptable manner on the possible risks associated with the pharmaceutical use of lindane, and inform them about alternatives."

Regarding lindane agricultural uses:

"i) The Parties will explore mechanisms to strengthen outreach and education efforts. This may include exchanging information on cautionary labeling, development of fact sheets, other guidance documents, workshop proceedings etc;

ii) The Parties are committed to sharing information regarding; adverse effects associated with lindane, new regulatory actions, education strategies, and worker safety;

iii) The Parties will ensure that indigenous populations are suitably advised in a culturally acceptable manner on the possible risks associated with the use of lindane, with the presence of lindane and/ or HCH isomers in the environment, with the risk of exposure through traditional foods, and on the use of available alternatives as applicable; and

[60] Commission for Environmental Cooperation. November 2006. The North America Regional Action Plan (NARAP) on Lindane and Other Hexachlorocyclohexane (HCH) Isomers. http://www.cec.org/files/PDF/POLLUTANTS/LindaneNARAP-Nov06_en.pdf

iv) The Parties will undertake the implementation of "The Globally Harmonized System of Classification and Labeling" (GHS) consistent with the NAFTA Technical Working Group on pesticides initiative in order to provide consistency of labeling information for approved lindane applications as appropriate."

"In addition to the outreach and education activities described under the specific uses of lindane, the Secretariat will encourage lindane manufacturers, formulators, and distributors to develop publicly available best practices for lindane use and application and extend these best practices into training and awareness programs for their clients."

Finally, listing alpha-HCH and beta-HCH in Annex A will involve control measures that are straight forward to communicate and therefore should be effective and suitable, even in countries that have limited chemical regulatory infrastructure.

F. Status of control and monitoring capacity (provide summary information and relevant references):

Listing alpha-HCH and beta-HCH in Annex A would be the most cost-effective option in countries that lack the needed infrastructure to adequately monitor production and uses of lindane and/or its isomers. Monitoring may require resources and infrastructure that the country does not have.

The US Centers for Disease Control and Prevention (CDC) is engaged in an ongoing assessment of the U.S. population's exposure to environmental chemicals using bio-monitoring as a tool. Bio-monitoring involves assessment of human exposure to chemicals by measuring the chemicals or their metabolites in human specimens such as blood or urine. The overall range of beta-HCH detected among US populations tested between 1999 and 2002 (across the CDC studies two and three) ranged from 49%-62%.[61]

The U.S. Environmental Protection Agency (EPA) identifies the most serious hazardous waste sites in the U.S. These sites are then placed on the National Priorities List (NPL) and are targeted for long-term federal clean-up activities. Alpha-, beta-, gamma-, and delta-HCH have been found in at least 146, 159, 189, and 126, respectively of the 1,662 current or former NPL sites. [62] Studies documenting HCH residues in breastmilk and blood have been carried out worldwide. These studies are described in the beta-HCH Risk Profile.[63]

[61] National Center for Environmental Health, U.S. Centers for Disease Control and Prevention, Second National Report on Human Exposures to Environmental Chemicals. January 2003; and Third National Report on Human Exposure to Environmental Chemicals. July 2005. Available at http://www.cdc.gov/exposurereport.
[62] ATSDR. 2005, Op cit.
[63] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9 http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf

G. Any national or regional control actions already taken, including information on alternatives, and other relevant risk management information:

Since lindane is the parent chemical whose manufacture produces alpha- and beta-HCH, any control measures taken for lindane have a corollary controlling action on these isomers. The status of alpha- and beta-HCH under international conventions has been previously described.[64]

North America:

The North American Commission for Environmental Cooperation released the North America Regional Action Plan (NARAP) on Lindane and Other Hexachlorocyclohexane (HCH) Isomers in November 2006.[65]

The NARAP states that "The three North American countries, Canada, Mexico, and the United States of America, under the auspices of the North American Commission for Environmental Cooperation, (CEC) have recognized that the organochlorine pesticide lindane and other isomers of hexachlorocyclohexane (HCH) may constitute a risk to human health and the environment.

"The three Parties of the CEC also recognize that lindane and other isomers of HCH meet several internationally accepted criteria for persistence, bioaccumulation factors and toxicity. While lindane is no longer produced in North America, it continues to be used for varying applications and in different quantities in the three countries. Consequently, the Parties, through the development of this trilateral action plan, will reduce the risks from exposure to the various isomers of HCH, and where warranted, eliminate or ban uses of lindane in particular. This will be accomplished through regulatory and management actions, outreach and education efforts, science and research, capacity building, and collaborative cross-border activities.

"On a regional basis, the three Parties will work together to implement the actions described in this plan. A key recommendation is to establish a tri-lateral implementation task force consisting of national representatives with expertise in the fields of health and environmental aspects of lindane and other HCH isomers, to oversee these activities. In addition, based on information gained through the development of this regional action plan, the Parties will participate in other international initiatives to promote emissions reductions from other global sources of lindane.

"On a national basis, each Party will address lindane and other isomers of HCH as indicated in the action plan."

In February 2006 US EPA released for public comment a revised risk assessment for lindane that expanded the risk evaluation from lindane only to include other HCH

[64] Risk profile on beta hexachlorocyclohexane UNEP/POPS/POPRC.3/20/Add.9
http://www.pops.int/documents/meetings/poprc/chem_review/BetaHCH/BetaHCH_RiskProfile_e.pdf

[65] Commission for Environmental Cooperation. November 2006. The North America Regional Action Plan (NARAP) on Lindane and Other Hexachlorocyclohexane (HCH) Isomers.
http://www.cec.org/files/PDF/POLLUTANTS/LindaneNARAP-Nov06_en.pdf

isomers. The "Assessment of Lindane and Other Hexachlorocyclohexane Isomers" examines environmental fate and human health risk from exposure to alpha- and beta-HCH.[66]

In April 2000, the Sound Management of Chemicals Working Group of the North American Commission on Environmental Cooperation submitted their conclusions that lindane and other HCH isomers "pose risk to humans and wildlife" in North America (see http://www.cec.org/pubs_docs/documents/index.cfm?varlan=english&ID=1032). The Working Group "acknowledged that lindane is of regional concern and that there would be real benefits obtained from collective action in the development and implementation of a *North American Regional Action Plan on Lindane*." [67]

In 2002, the U.S. state of California banned pharmaceutical use of lindane due to concerns about water quality, when high levels of this treatment for head lice and scabies were found to be impacting wastewater quality. Wastewater treatment engineers in Los Angeles calculated that a single treatment for head lice or scabies contains enough lindane to bring 6 million gallons of water above the California water quality standard for lindane. Before Los Angeles County outreach efforts on pharmaceutical lindane began in 1999, the average wastewater concentration of lindane was 36 ppt. By 2006, four years after the ban took effect, lindane concentrations had dropped to almost undetectable concentrations in California. The California experience suggests elimination of pharmaceutical lindane produced environmental benefits, was associated with a reduction in reported unintentional exposures to not only lindane[68] but also the alpha- and beta-HCH isomers.

H. Other relevant information for the risk management evaluation

I. Other information requested by the POPRC

[66] US Environmental Protection Agency, Office of Prevention, Pesticides and Toxic Substances, Assessemt of Lindane and Other Hexachlorocyclohexane Isomers. Feb 2006.
[67] Ibid.
[68] Humphreys, E.H. et.al. 2007. Outcomes of the California Ban on Pharmaceutical Lindane: Clinical and Ecological Impacts. *Environmental Health Perspectives* doi:10.1289/ehp.10668 available at http://dx.doi.org/