3.2 TOXICOLOGY

3.2.1 Environment

If analysed for in tissues or environmental samples, some POPs will almost always be found. As is the case with many environmental pollutants, it is most difficult to establish causality of illness or disease that is directly attributable to exposure to a specific persistent organic pollutant or group of POPs. This difficulty is further underscored by the fact that POPs rarely occur as single compounds and, individual field studies are frequently insufficient to provide compelling evidence of cause and effect in their own right. More to the point, however, is the fact that the significant lipophilicity of these compounds means that POPs are likely to accumulate, persist and bioconcentrate and could, thus, achieve toxicologically relevant concentrations even though discrete exposure may appear limited.

Experimentally, POPs have been associated with significant environmental impact in a wide range of species and at virtually all trophic levels. While acute effects of POPs intoxication have been well documented, adverse effects associated with chronic low level exposure in the environment is of particular concern. Noteworthy in this context is the long biological half life of POPs in biological organisms thereby facilitating accumulation of seemingly small unit concentrations over extended periods of time. For some POPs, there is some experimental evidence that such cumulative low level exposures may be associated with chronic non-lethal effects including potential immunotoxicity, dermal effects, impairment of reproductive performance and frank carcinogenicity.

Immunotoxicity in association with exposure to different POPs has been reported by several authors. Investigators have demonstrated immune dysfunction as a plausible cause for increased mortality among marine mammals and have also demonstrated that consumption of persistent organic pollutant contaminated diets in seals may lead to vitamin and thyroid deficiencies and concomitant susceptibility to microbial infections and reproductive disorders. Investigators have also noted that immunodeficiency has been induced in a variety of wildlife species by a number of prevalent POPs, including TCDD's, PCBs, chlordane, HCB, toxaphene and DDT. Exposure to POPs has been correlated with population declines in a number of marine mammals including the common seal the harbour porpoise, bottle-nosed dolphins and beluga whales from the St. Lawrence River. More notably, a clear cause and effect relationship has been established between reproductive failure in mink and exposure to some POPs.

The scientific literature has demonstrated a direct cause and effect relationship in mink and ferrets between PCB exposure and immune dysfunction, reproductive failure, increased kit mortality, deformations and adult mortality. Similarly, investigators have also demonstrated a convincing correlation between environmental concentrations of PCBs and dioxins with reduced viability of larvae in several species of fish. Noteworthy as well is a report suggesting significant reproductive impairment in a number of Great Lakes species described as top level predators dependent on the Great Lakes aquatic food chain. Supporting this is the observation that wildlife, including stranded carcasses of St. Lawrence beluga whales, with reported high incidence of tumours have contained significantly elevated concentrations of PCBs mirex, chlordane and toxaphene. A 100% incidence of thyroid lesions in coho, pink and chinook salmon sampled in the Great Lakes over the last two decades has also been reported to be associated with increased body burdens of POPs.

3.2.2 Human health

As noted for environmental effects, it is also most difficult to establish cause and effect relationships for human exposure of POPs and incident disease. As with wildlife species, humans encounter a broad range of environmental exposures and frequently to a mixture of chemicals at any one time. Much work remains to be done on the study of the human health impact of exposure to POPs, particularly in view of the broad range of concomitant exposing experienced by humans. The weight of scientific evidence suggests that some POPs have the potential to cause significant adverse effects to human health, at the local level, and at the regional and global levels through long-range transport. For some POPs, occupational and accidental high-level exposure is of concern for both acute and chronic worker exposure. The risk is greatest in developing countries where the use of POPs in tropical agriculture has resulted in a large number of deaths and injuries. In addition to other exposure routes, worker exposure to POPs during waste management is a significant source of occupational risk in many countries. Short-term exposure to high concentrations of certain POPs has been shown to result in illness and death. For example, a study in the Philippines showed that in 1990, endosulfan became the number one cause of pesticide-related acute poisoning among subsistence rice farmers and mango sprayers. Occupational, bystander and near-field exposure to toxic chemicals is often difficult to minimize in developing countries. Obstacles in managing workplace exposure are in part due to poor or non-existent training, lack of safety equipment, and substandard working conditions. As well, concerns resulting from near-field and bystander exposure are difficult to identify due to inadequacies in monitoring of the ambient environment and inconsistencies in medical monitoring, diagnosis, reporting and treatment. These factors contribute to a lack of epidemiological data. Earliest reports of exposure to POPs related to human health impact include an episode of HCB poisoning of food in south-east Turkey, resulting in the death of 90% of those affected and in other exposure related incidences of hepatic cirrhosis, porphyria and urinary, arthritic and neurological disorders. In another acute incident in Italy in 1976, release of 2,3,7,8-TCDD to the environment resulted in an increase of chloracne.

The US EPA is currently reviewing dioxin related health effects especially for the non-carcinogenic endpoints such as immunotoxicity, reproductive disorders and neurotoxicity. Such frank expressions of effects are not as common in the case of exposure to lower concentrations derived from the environment and the food chain. Laboratory and field observations on animals, as well as clinical and epidemiological studies in humans, and studies on cell cultures collectively demonstrate that overexposure to certain POPs may be associated with a wide range of biological effects. These adverse effects may include immune dysfunction, neurological deficits, reproductive anomalies, behavioural abnormalities and carcinogenesis. The scientific evidence demonstrating a link between chronic exposure to sublethal concentrations of POPs (such as that which could occur as a result of long-range transport) and human health impacts is more difficult to establish, but gives cause for serious concern. Swedish investigations have reported that dietary intake of PCBs, dioxins and furans may be linked to important reductions in the population of natural killer cells (lymphoytes), while other reports have suggested that children with high organochlorine dietary intake may experience rates of infection some 10-15 times higher than comparable children with much lower intake levels. The developing fetus and neonate are particularly vulnerable to POPs exposure due to transplacental and lactational transfer of maternal burdens at critical periods of development. It has also been reported that residents of the Canadian Arctic, and who exist at the highest trophic level of the Arctic aquatic food chain, have PCB intake levels in excess of the acceptable daily intake, and that may place this population at special risk for

reproductive and developmental effects. In another report, children in the northern Quebec region of Canada who have had significant exposure to PCBs, dioxins and furans through breast milk also had a higher incidence of middle ear infections than children who had been bottle fed. Most authors, however, conclude that the benefits of breast feeding outweighs the risks. Studies of carcinogenesis associated with occupational exposure to 2.3.7.8-TCDD also seem to indicate that extremely high-level exposures of human populations do elevate overall cancer incidence. Laboratory studies provide convincing supporting evidence that selected organochlorine chemicals (dioxins and furans) may have carcinogenic effects and act as strong tumour promoters.

More recently, literature has been accumulating in which some researchers have suggested a possible relationship between exposure to some POPs and human disease and reproductive dysfunction. Researchers have suggested that the increasing incidence of reproductive abnormalities in the human male may be related to increased estrogen (or estrogenic type) compound exposure in vitro, and further suggest that a single maternal exposure during pregnancy of minute amounts of TCDD may increase the frequency of cryptorchidism in male offspring, with no apparent sign of intoxication in the mother. Associations have been made between human exposure to certain chlorinated organic contaminants and cancers in human populations. Preliminary evidence suggests a possible association between breast cancer and elevated concentrations of DDE. While the role of phytoestrogens and alterations in lifestyle cannot be dismissed as important risk factors in the dramatic increase in estrogen dependent breast cancer incidence, correlative evidence suggesting a role for POPs continues to mount. This latter theory has been supported in a report that noted that levels of DDE and PCBs were higher for breast cancer case patients than for control subjects, noting that statistical significance was achieved only for DDE. While a causal relationship between organochlorine exposure and malignant breast disease remains far from proven, the possibility thatchronic low level exposure, when coupled with the known bioaccumulative properties of POPs, may even contribute in some small way to overall breast cancer risk has extraordinary implications for the reduction and prevention of this very important disease.

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An Assessment Report on:
DDT-Aldrin-Dieldrin-Endrin-Chlordane
Heptachlor-Hexachlorobenzene
Mirex-Toxaphene
Polychlorinated Biphenyls
Dioxins and Furans

Prepared by:
L. Ritter, K.R. Solomon, J. Forget
Canadian Network of Toxicology Centres
620 Gordon Street
Guelph ON Canada
and
M. Stemeroff and C.O'Leary
Deloitte and Touche Consulting Group
98 Macdonell St., Guelph ON Canada

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