All over the world, chlorine-containing industrial chemicals are wreaking havoc with the environment and our health:

- In the stratosphere, chlorinated compounds are destroying the ozone layer that shields life on earth from ultraviolet radiation.

- Across the entire globe, hundreds of chlorine-based poisons are slowly building up in the air, water, and food chain -- and in our bodies, as well.

- New scientific evidence implicates these chemicals in severe and widespread health problems in people and wildlife, including infertility, impaired childhood development, immune system damage, and cancer.

Chlorine is the common link in many of the world's most notorious environmental poisons: dioxin, DDT, Agent Orange, PCBs, and the ozone-destroying chlorofluorocarbons (CFCs) are all based on chlorine. These and other chlorine-containing substances dominate government lists of "priority pollutants" that threaten health and the environment. But thousands of other chlorinated poisons that cause similar harm are not regulated or even monitored.

The global threat posed by the toxic "chlorine soup" now present in the ecosystem is too complex to be solved by addressing these chemicals one at a time. If we wish to preserve the life-sustaining capacity of the planet, the root of the problem - - the production and use of chlorine -- must be phased out.

"The dynamic growth of chlorine chemistry during the 50s and 60s represents a decisive mistake in twentieth century industrial development, which would not have occurred had our present knowledge as to environmental damage and health risks due to chlorine chemistry then been available." -- German Council of Experts for Environmental Issues, 1990.
CHLORINE CHEMISTRY: INDUSTRY'S ADDICTION

Chlorine chemistry starts with ordinary salt -- sodium chloride, a stable, natural substance that flows constantly through the ecosystem and our bodies. The chemical industry creates chlorine gas (Cl2) by passing huge quantities of electricity through salt-water, splitting the salt molecule and fundamentally changing the character of the chlorine in it. Chlorine gas is an extremely reactive and poisonous substance that rarely occurs in nature.

Unlike chloride, chlorine gas bonds quickly with organic matter to form a new class of chemicals called "organochlorines." Most chlorine is combined with petrochemicals to produce organochlorine products, including plastics (especially PVC, or "vinyl"), pesticides, solvents, and other chemicals. About 20 percent of chlorine gas is sold for use outside the chemical industry, primarily as a bleach in the production of paper. Only 1 percent of chlorine is used to disinfect drinking water.

Many more organochlorines are produced by accident. Because chlorine is so reactive, it combines quickly with organic matter to form a variety of very toxic by-products and wastes. Hundreds of these accidental organochlorines are released when chlorine is used to bleach pulp, disinfect water, manufacture other organochlorines, and whenever chlorine-containing chemicals and wastes are burned. These by-products -- including the infamous dioxins and furans -- are typically even more dangerous than the intentionally-produced chemicals.

Chlorine chemistry did not exist on a commercial scale until the early 20th Century. Even then, only limited production took place until World War I, when chlorine and related chemicals were used as chemical weapons. After World War II, the chemical industry sought new markets for chlorine-based products, and chlorine production expanded rapidly, doubling each decade. Now, the chemical industry produces about 40 million tons of chlorine annually. Demand for chlorine in Europe and North America is no longer growing, so the industry is seeking to expand markets in Latin America, Asia, and the Middle East. The world's largest chlorine producers are the chemical giants Dow, Occidental, ICI, Solvay, PPG, Olin, Enichem, and Bayer.

SLOWLY POISONING THE PLANET

One reason that organochlorines are useful to industry is that they tend to be very stable: they resist natural break down processes. But this same quality means that they also persist in the environment for decades or centuries. Some organochlorines can be degraded slowly, but the breakdown products are usually other organochlorines, and these are often even more toxic or persistent than the original chemical. Because of their long lifetimes, even small discharges of these chemicals build up in the environment over time. As industry produces more and more chlorine, the total global burden of organochlorines continues to grow.

From the North pole to the deep oceans, organochlorines can be found in the air, water, and food chain. People who live or work near sources of chlorine pollution are exposed most immediately, but the problem is truly global: even
polar bears, whales, and Inuit people living far from any industry now carry extremely high levels of dioxins, PCBs, and other organochlorines in their body tissues.

Closer to home, scores of organochlorines can be found in the air we breathe and the water we drink. Our greatest exposures, however, come through our food, especially fish, meats, and dairy products. Many organochlorines concentrate in our fats, so they multiply in concentration as they move up the food chain. The levels of these chemicals in the bodies of birds, fish, people, and marine mammals are millions of times greater than the amounts found in the ambient environment. Beluga whales in the St. Lawrence river, for instance, have accumulated such high levels of PCBs that dead whales are legally hazardous waste.

Humans are at the top of the food chain, so our bodies serve as magnets for organochlorine pollution in the environment. 177 organochlorines -- including pesticides, dioxins, PCBs and many others -- have been found in the fat, mothers' milk, semen, blood and breath of the general U.S. and Canadian population. Many more organochlorines are known to be present but have not yet been specifically identified.

Our children receive the highest doses. Organochlorines are passed from one generation to the next through the placenta and breast milk, during the most sensitive periods of development. Levels of some organochlorine pesticides in the mothers' milk of women in many industrialized nations are so high that the milk would violate maximum standards for cow's milk. One Swedish study found that an average breast-fed infant weighing 5 kilograms is exposed to PCBs, dioxins and furans at levels 50 times greater than the the "acceptable daily intake."

THE HEALTH THREAT

According to the American Public Health Association, organochlorines "are found to pose public health risks involving the workplace, consumer products and the general environment." Virtually all organochlorines that have been studied have been found to cause at least one of a wide range of effects, including genetic mutations, disruption of hormones, suppression of the immune system, birth defects and impaired childhood development, reproductive dysfunction and infertility, cancer, endometriosis, and neurological damage, often at very low doses.

Many organochlorines mimic or otherwise disrupt our hormones -- the chemical messengers the body uses to turn natural biological processes on and off. By interfering with the endocrine system, even tiny doses of organochlorines can trigger a cascade of effects leading to serious effects on reproduction, development reproduction, development, and behaviour.

The most complete picture of the effects of chlorine pollution comes from the Great Lakes, where scientists have been studying ecosystem health for decades. In 14 species -- including bald eagles, salmon, beluga whales, and humans --
organochlorines have been linked to epidemic health problems. The effects, which include birth defects, infertility, feminization of males, population declines, hormonal disruption, tumors, and immune suppression, were most severe in the offspring of the exposed animals. The Great Lakes have been called a "canary in the coal mine" for damage that can be expected worldwide. Already, similar effects have been found in marine mammals, fish, birds, and wildlife from the Baltic, the Wadden Sea, the Arctic, and the U.S. Pacific Coast.

When wildlife are affected by environmental contamination, we must assume humans are at risk, as well. For decades, we have known for decades that workers exposed to organochlorines are at higher risk of cancer, infertility and other reproductive problems, neurological damage, and other health problems. Recently, researchers have found that the levels of dioxin and other chlorine-based substances in the environment are already high enough to cause subtle but severe health damage. Now, new scientific evidence suggests that organochlorines may be contributing to the incidence of disease throughout the general population:

- Increases in a number of types of cancer, including cancers of the breast, testes, bladder, and colorectum, as well as immune-related cancers;
- Declining sperm counts, reduced penis size, and abnormalities of the male reproductive tract;
- Endometriosis and other reproductive effects in women;
- Impaired childhood development, learning and behavioural deficiencies, and birth defects;
- Immune system impairment.

Finally, the health impacts of ozone destruction may be catastrophic. The United Nations Environmental Program has estimated that current ozone depletion trends will result in 300,000 cases of skin cancer worldwide each year, plus at least 1.6 million cases of cataracts annually and unknown number of cases of infectious disease caused by immune system disorders. Increased UV radiation is also expected to reduce productivity among crops, livestock, and the ocean food chain, leading to deficiencies in the world's food supply.

Despite all this evidence, the chemical industry continues to claim that the health threat posed by organochlorine pollution has not yet been proven. The industry demands the right to continue discharging toxic chemicals until "conclusive proof" of harm to humans is established, one chemical at a time. With what is already known about the hazards of chlorinated chemicals as a class, this position amounts to a call for a grand biological experiment with the world's population as guinea pigs.
GOING TO THE ROOT: PHASING OUT CHLORINE

At the root of the thousands of organochlorine product and by-products is a single substance: industrially-produced chlorine. Regulating these thousands of chemicals one at a time would take centuries. Further, when one substance is banned, the chlorine industry develops new uses for chlorine that have the same or similar effects. Finally, the complex mixtures of by-products that are formed in chlorine-based processes cannot be controlled with chemical-by-chemical regulations. We need to focus on the entire class of organochlorines and the chlorine-based industrial processes that give rise to these mixtures.

Chemical policies should be based on the precautionary principle: when there is reason to believe a substance or class of substances may cause harm to health or the environment, it should not be used or produced. On this basis, the American Public Health Association resolved in 1993 that organochlorines should be treated as a class and phased-out, with exceptions made only if industry can show that an individual use is safe or essential.

With a single programme -- a chlorine phase-out -- much of the world’s most severe toxic pollution could be stopped. In 1993, both the Paris Commission on the North East Atlantic and the Barcelona Convention on the Mediterranean agreed that discharges of persistent bioaccumulative chemicals must be eliminated, with priority given to sources of organochlorines. In 1992 and again in 1994, the International Joint Commission on the Great Lakes agreed with this view, recommending that the U.S. and Canada "develop timetables to sunset the use of chlorine and chlorine-containing compounds as industrial feedstocks and that the means of reducing or eliminating other uses be examined."

It is time for governments to follow these recommendations with immediate action. Chlorine should be the focus of a planned phase-out, with priority given to the largest and most dangerous uses for which alternatives are ready and waiting: PVC plastic, pulp and paper mills, pesticides, solvents and incinerators.

There are a few minor uses of chlorine -- such as chlorine-containing pharmaceuticals, which account for less than one percent of total chlorine use -- that serve an important social need but for which alternatives have not yet been identified; exceptions or delays can be made while development of safer alternatives continues. But the phase-out should begin immediately in the largest and most dangerous chlorine uses, for which alternatives are now available.

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BOX QUOTE

"It is prudent, sensible and indeed necessary to treat these [chlorinated organic] substances as a class rather than as a series of isolated individual chemicals. Further, in many cases, alternative production processes do exist.... The Commission concludes that the use of chlorine and its compounds should be avoided in the manufacturing process.... The Commission there
fore recommends that the Parties, in consultation with industry and other affected interests, develop timetables to sunset the use of chlorine and chlorine-containing compounds as industrial feedstocks." -- International Joint Commission on the Great Lakes, 1992.

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CHLORINE USES AND ALTERNATIVES

Alternatives are available now for all major uses of chlorine. For example:

PVC plastic, also known is vinyl, is the largest single use of chlorine. Used in packaging, toys, furniture, pipes, flooring, window frames, and other products, PVC has been found to be the most environmentally damaging of all plastics -- due to the release of organochlorines and other chemicals throughout its lifecycle. During PVC production, huge amounts of extremely toxic feedstocks and by-products are produced and released to the environment. The burning of PVC products -- either in incinerators or in accidental building fires -- gives rise to large amounts of dioxins and other toxic emissions. Other toxic ingredients -- such as lead, cadmium, and phthalates -- are added to PVC to give it useful properties, and these are also released during production, use, or disposal of the plastic.

PVC can be phased out relatively easily. Products now made from PVC can be replaced with wood, metals, glass, or chlorine-free plastics, and unnecessary packaging should be eliminated entirely. Dozens of European communities, hospitals, retailers, and manufacturers of furniture, automobiles, and flooring have virtually eliminated PVC from their product lines or construction projects.

Pulp and paper companies use chlorine and other chlorine-based bleaches (such as chlorine dioxide) in the production of bright white paper. This process produces a cocktail consisting of thousands of organochlorines -- over 300 of which have been identified -- including dioxins, furans, and other highly toxic, persistent substances. These by-products are released by the thousands of tonnes per year into local waterways and in air emissions; they are also found in significant concentrations in the final paper products and in the sludges from these mills. Swedish scientists have documented severe damage to fish and ecosystem balance in the Baltic Sea, and the U.S. Environmental Protection Agency have found that people who eat fish caught downstream from chlorine-bleached pulp mills are at cancer risks as high as one in 50.

Among the best alternatives to chlorine are the oxygen-based bleaches, including hydrogen peroxide, ozone, and oxygen itself. At least 26 pulp mills around the world are already producing high-quality, totally chlorine-free pulp and paper, but many other mills have not yet made the switch. Unbleached paper should be used whenever possible. Once chlorine is eliminated, mills can "close the loop" and begin to recycle the water and other chemicals they use -- an important step towards a sustainable paper industry.
Chlorinated solvents are used by manufacturing industries for cleaning and coating processes. Chlorinated solvents -- most of which can cause cancer, neurological damage, and reproductive toxicity -- are recognized as severe workplace hazards and are widespread pollutants of air and groundwater. The use of chlorinated solvents at dry cleaners has been found to result in severe contamination of residences and groceries nearby. Some chlorinated solvents are important contributors to ozone depletion.

Manufacturing industries can substitute water-based or mechanical cleaning methods for chlorinated solvents. Chlorine-free methods are now being used by major manufacturers of automobiles, paints, electronics and other equipment. Concerned dry cleaners in the U.S., the UK, Sweden and Germany have adopted steam- and water-based methods of clothes cleaning which eliminate the use of chlorinated solvents. And chlorine-free refrigerators and air conditioners -- using hydrocarbons, water, ammonia, or other cooling methods -- are now being used and produced on a mass scale.

Pesticides account for only a small portion of chlorine use but have major environmental impacts. The majority of synthetic pesticides are either organochlorines or involve organochlorines in the manufacturing process. The environmental and health hazards of pesticides are well-known, and contamination of groundwater, rivers, lakes, oceans, fog, rain, snow and food with both "older generation" pesticides (including DDT, chlordane, and dieldrin) and the chemicals that replaced them (such as atrazine, alachlor and 2,4-D) is nearly universal. This result is no surprise, since persistent pesticides are deliberately spread into the open environment, and less than 0.1 percent of the total quantity applied actually reaches its target crop.

The U.S. National Academy of Sciences has found that ecological or "organic" agriculture is extremely effective, enhancing farmers' yields and profits while eliminating dangerous pesticides. These methods rely on improved crop choice, mixing and rotation; mechanical tilling methods; and the use of natural predators and biological pesticides. By working with nature, organic agriculture prevents the widespread problem by which pests evolve resistance to synthetic chemicals and return in greater force just a few years later.

Disinfection of sewage and drinking water is another small use of chlorine with major health impacts. Chlorine combines with the organic matter in water to produce hundreds of organochlorine by-products. Among the best-understood are the carcinogenic trihalomethanes, including chloroform. Chlorinated effluents from sewage plants have caused severe damage to fish and aquatic ecosystems. And a large number of studies have linked chlorinated drinking water to bladder cancer, colorectal cancer, birth defects, low birth weight, and changes in fat metabolism that can lead to high blood cholesterol and increased risk of cardiovascular disease. By relying on chlorine as a disinfectant, we have traded one serious public health problem -- infectious disease -- for a new one: chemically-induced diseases.

Fortunately, there are other means to provide safe water that eliminate these hazards. Ultraviolet light (UV), ozone treatment, and improved filtration can
eliminate the use of chlorine in water treatment systems. Hundreds of municipalities around the world already are using these alternative disinfection technologies, and several large cities in Europe are relying on these methods to deliver safe, chlorine-free drinking water to their communities. And chlorine-free alternatives that use oxygen, ozone, UV, ionic treatment and other methods are available to disinfect swimming pools, as well.

Even in complex chemical manufacturing processes, alternatives to chlorine are available. In fact, major chemical companies such as ARCO, Dupont, and Monsanto have developed chlorine-free methods to manufacture chemicals that once relied on chlorine. Even in the pharmaceutical industry -- where less than 1 percent of chlorine is used -- some manufacturers have replaced chlorinated solvents and intermediates with safer alternatives.

TOXIC ECONOMICS

The chemical industry has argued that the chlorine phase-out will devastate the economy. But industry's reliance on toxic chemicals and wasteful technologies is no more healthy economically than it is ecologically. In fact, implementing alternatives to chlorine will in most cases save money and create jobs.

In the paper industry, for instance, the conversion to oxygen bleaching results in net savings due to reduced costs for chemical procurement, pollution control, waste disposal, liability and remediation, as well as the opportunity to install "closed-loop" systems with further savings on water, chemicals, and energy. And as consumers increasingly demand environmentally sound paper, producers that adopt chlorine-free bleaching will hold the strongest position in the competitive global marketplace of the future.

Industries that have switched from chlorinated solvents to cleaner and more efficient processes have also benefited financially, due to savings on chemical procurement, waste disposal and liability costs. Dry cleaning shops that switch from chlorinated solvents to water-based cleaning methods increase their profits, lower their costs, receive a 78 percent higher return on investment, and create 21 percent more jobs, according to the U.S. EPA.

Beyond these direct savings, the environmental and health damage caused by chlorine-based pollution costs society hundreds of billions of dollars each year. Expenses for health care, diminished productivity, waste-disposal, and remediation of contaminated sites and groundwater are a tremendous drag on the economy. A healthy population and a clean environment are essential to a sound economy.

The net economic effects of phasing-out chlorine will thus be positive. But for chemical workers now employed making chlorine and related chemicals, the chlorine phase-out may mean lost jobs. Greenpeace supports the worker protection programs advocated by many labour unions; these "Workers' Superfund" programmes, financed by taxes on chlorine and related chemicals,
would provide meaningful compensation and opportunities for higher education and re-employment for any workers displaced by the chlorine-phase out. Further, the Fund can be used to minimize the dislocation caused by the transition by insuring that the new investment in chlorine-free alternatives takes place in the same locations where the chlorine industry was once sited. Workers and communities, who did not make the decision to produce poisons in the first place, should not be forced to bear the economic burden of the transition to a non-toxic economy.

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