WHITE PAPER

The Precautionary Principle and the City and County of San Francisco

March 2003

> When an activity raises threats of harm to human health or the environment, precautionary measures should be taken even if some cause and effect relationships are not fully established scientifically.
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> In this context the proponent of an activity, rather than the public, should bear the burden of proof.
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> The process of applying the Precautionary Principle must be open, informed and democratic and must include potentially affected parties. It must also involve an examination of the full range of alternatives, including no action.—*1998 Wingspread Statement on the Precautionary Principle*

Introduction

Chapter One of the Environment Code for the City and County of San Francisco states, "All officers, boards, commissions, and departments of the City shall implement the Precautionary Principle in conducting the City and County's affairs." This White Paper describes the history, intent, content, and implications of the Precautionary Principle. It explains how, by taking this step, San Francisco's leaders and citizens affirm that:

- People have a duty to take anticipatory action to prevent harm;
- Proponents of products and services bear responsibility for the safety of those products and services;
- Decision makers will examine a full range of alternatives and select alternatives with the least harmful impact on environmental health and human health;
- Decisions will be participatory, transparent, and informed by the best available science and complete product information;
- Decision makers will consider a full range of costs of products and services, including manufacturing, use, and disposal. Economic evaluations will broadly consider long-term costs and savings of environmental policies.

I. Why precaution now?

A. The changing world

In recent years scientists have been taking stock of human influence on the planet. (See, for example, Vitousek et al. 1997.) They have concluded that growth in human population and depletion of resources is changing the earth in unprecedented ways. Among their findings are the following:

- Over 6 billion people inhabit the planet, and reasonable mid-level estimates predict 9-10 billion by mid-21st century. Two and a half more "earths" would be needed to support today's population if everyone were to use as many resources as Americans do.

- Some 85,000 industrial chemicals mingle with the world's ecosystems; many contaminate its human and non-human inhabitants and have been found in their breast milk, egg yolks, ovarian follicles, and amniotic fluid. The toxicity of most is unknown or poorly understood.

- Large numbers of plant and animal species have been driven to extinction, and most marine fisheries are severely depleted. More than half the world's coral reefs are threatened by human activities.

B. Human exposures

Biomonitoring—measurement of presence of environmental toxicants in human bodies—has revealed that people absorb toxic chemicals in their bodies as part of everyday life (CDC 2003). For example, a recent analysis by the Mount Sinai School of Medicine (EWG 2002) found 167 chemical contaminants in nine volunteers (an average of 91 in each), including:

- 53 chemicals linked to cancer in humans and lab animals;
- 62 that are toxic to the brain and nervous system;
- 55 associated with birth defects or abnormal development;
- 55 chemicals toxic to the reproductive system;
- 53 that are toxic to the immune system; and
- 55 chemicals for which no health information is available.

Centers for Disease Control tests show that children are disproportionately exposed to many substances. Recent science indicates that early exposures to certain substances may damage the immune system (Weisglas-Kuperus et al. 2000) or increase risk of asthma, high blood pressure, or cancer in later life (Sorensen et al., 1999, Peden et al. 2000; Czene et al. 2002, Hemminki and Li, 2002).

C. Changing patterns of illness

Health scientists have recently identified troubling trends in patterns of human disease and impairment. (See, for example, McCally 2000, Schettler 2002.):

- Chronic diseases and conditions affect more than 100 million men, women, and children in the United States—more than a third of the population. Cancer, asthma, Alzheimer's disease, autism, birth defects, developmental disabilities, diabetes, endometriosis, infertility, multiple sclerosis, and Parkinson's disease are becoming increasingly common, and mounting evidence plausibly links these diseases to environmental toxins.

- Nearly 12 million children in the U.S. (17 percent) suffer from one or more developmental disabilities. Learning disabilities alone affect 5-10 percent of children in public schools, and these numbers are increasing. Attention deficit hyperactivity disorder conservatively affects 3-6 percent of all school children, and the numbers may be considerably higher. The incidence of autism appears to be increasing. (Schettler et al., 2000)

- Asthma prevalence has doubled in the last 20 years. San Francisco has one of the highest hospitalization rates for asthma attacks in children under 15 in urban California counties. In the city's Bayview–Hunters Point section, one in six children suffer from asthma, according to the San Francisco Department of Public Health's most recent study.

- The age-adjusted incidence of melanoma, lung cancer in women, non-Hodgkins lymphoma, and cancers of the prostate, liver, testis, thyroid, kidney, breast, brain, esophagus, and bladder has increased over the past 25 years. (SEER 1996) Breast cancer, for example, now strikes more women worldwide than any other type of cancer. Rates have increased 50 percent during the past half century. In the 1940s, the lifetime risk of breast cancer was one in 22. Today's risk is one in eight in the US and rising, (Evans 2002) with Marin County's risk factor at one in seven. Marin County has a cancer rate nearly 40 percent higher than the national average.

- In the U.S., the incidence of some birth defects, including male genital disorders, some forms of congenital heart disease, and obstructive disorders of the urinary tract, is increasing. (Pew 2003, Paulozi 1999) Sperm density is declining in some parts of the U.S. and elsewhere in the world. (Swan et al., 1997)

D. Scientific evidence, scientific uncertainty

These changes in the environment and human health are well documented. However, for many of these phenomena, proving direct links is more complicated.

Sun exposure, smoking, and diet explain few of the health trends. Genetic factors explain up to half the population variance for a few of these conditions and far less for the majority of them. This suggests that other environmental factors play a role. Emerging

science suggests this as well. In laboratory animals, wildlife, and humans, considerable evidence documents a link between ambient levels of environmental contamination and malignancies, birth defects, reproductive success, impaired behavior, and immune system function. Scientists' growing understanding of how biological systems develop and function leads to similar conclusions. (Schettler 2002)

But serious, evident effects such as endocrine disruption, climate change, cancer, and the disappearance of species can seldom be linked decisively to a single cause. Scientific standards of certainty may be impossible to attain when causes and outcomes are multiple; latent periods are long; timing of exposure is crucial; unexposed, "control" populations do not exist; or confounding factors are unidentified.

E. Inadequate policies

Most current environmental regulations aim to control toxic substances as they are emitted as waste or measurable pollution rather than limiting or eliminating their use. Even these policies fail to control emissions where they may be most harmful, especially to children—the toxic chemicals in building materials, cleansers, pesticides, and the like, which are used in homes, garages, offices, and schools and disposed in incinerators or landfills.

However, the greatest weakness in policies on toxic substances and environmental conservation may be that they are based on the expectation that science can and must provide definitive proof of harm before protective action is taken.

Quantitative risk assessment is now the predominant method for determining the degree and likelihood of harmful side effects from products, technologies, and development projects. Under the standard model, risk assessments present numbers that purport to show how much harm might occur. In a second step, policy makers attempt to decide how much harm is acceptable. However, risk assessment, which became standard practice in the United States in the mid-1980s and was institutionalized in the global trade agreements of the 1990s, does not prompt decision makers to ask whether alternatives exist that would substantially *reduce* risk.

For example, a risk assessment may attempt to define how many children will suffer developmental disorders or cancer after playing with a plastic toy that leaches chemicals of poorly understood toxicity. With this risk assessment in hand, policy makers may then attempt to define how many diseased children (one in 10,000? 100,000?) would be acceptable. This process provides no opportunity to examine an alternative option, in which toys are only made from materials known to be safe for children.

When uncertainties are relatively small and the stakes are fairly clear, risk assessments may provide useful information and help society choose among alternatives. But when uncertainties are difficult, or even impossible, to resolve and the stakes are high—the health and learning power of children, life or death for an unknown number of individuals, the survival of species and ecosystems—risk assessment is inadequate as the

prime tool for decision making. Although risk assessments try to account for uncertainties, these projections are necessarily subject to assumptions and simplifications. Risk assessments usually address a limited number of potential harms, often missing social, cultural, or broader environmental factors that are difficult to quantify. They are often linked with limited cost-benefit assessments, which quantify immediate costs of regulations to producers but usually fail to account for costs and benefits to society over time.

Not only do risk assessments often fail to produce useful guidelines for action; they also consume enormous resources in strapped regulatory agencies. The risk assessment process—determining acceptable limits of harm, quantifying potential harm, and quantifying the costs of taking action to prevent harm—is based on important scientific tools but it places a heavy burden on those tools, requiring certain answers from an inherently inexact process. The sheer time and resource requirements of carrying out and interpreting a risk assessment can make it difficult for regulatory agencies to fulfill their broad mandate to protect human and environmental health. Identifying and substituting safer alternatives is a more effective use of agency resources, particularly at the local level.

F. Late lessons from early warnings

The slow pace of regulation, the insistence on "scientific certainty," and the weighting toward immediate monetary costs often give the benefit of doubt to products and technologies, even when harmful side effects are suspected. One result is that neither international environmental agreements nor national regulatory systems have kept up with the increasing pace and cumulative effects of environmental damage.

A report by the European Environment Agency in 2001 tallied the great costs to society of some of the most egregious failures to heed early warnings of harm. Radiation, ozone depletion, asbestos, Mad Cow disease, and other case studies show a familiar pattern: "Misplaced 'certainty' about the absence of harm played a key role in delaying preventive actions," the authors conclude.

They add, "The costs of preventive actions are usually tangible, clearly allocated and often short term, whereas the costs of failing to act are less tangible, less clearly distributed and usually longer term, posing particular problems of governance. Weighing up the overall pros and cons of action, or inaction, is therefore very difficult, involving ethical as well as economic considerations." (EEA 2001)

G. The Precautionary Principle and ethics

The Precautionary Principle is an ethical guide through this murky universe of harm, the uncertainty that is inherently part of science, and public policy. The Precautionary Principle links science with the responsible protection of human health and environmental health. All statements of the Precautionary Principle contain a version of this formula: *It is not necessary to wait for scientific certainty to take protective action.*

This has far-reaching implications for decision-making. The Precautionary Principle causes us to ask scientific questions about what we know and do not know, but it also guides us toward ethical and political questions, which science alone cannot answer:

- What are the consequences of our actions?
- Do we have better choices?
- Who will be harmed?
- Who is responsible?
- Do we know enough to act?

The ethical assumption behind the Precautionary Principle is that humans are responsible to protect, preserve, and restore the global ecosystems on which all life, including our own, depends. (Myers 2002)

II. History of the Precautionary Principle

A. An emerging principle of international law

In the 1980s, in the context of mounting evidence of unprecedented environmental changes surrounded by vast uncertainties, the concept of precaution began appearing in international environmental agreements. (See Raffensperger and Tickner 1999, Appendix B.) For instance:

- Beginning in 1984, a series of protocols called for a "precautionary approach" to reduce pollution in the North Sea.

- The 1987 Ozone Layer Protocol called for "precautionary measures" to control global emissions of ozone-depleting substances.

- In 1990, both the Bergen Declaration on Sustainable Development and the Second World Climate Conference contained this statement: "Where there are threats of serious or irreversible damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation."

At the Rio Earth Summit in 1992, precaution was enshrined as Principle 15 in the Rio Declaration on Environment and Development:

> In order to protect the environment, the precautionary approach shall be widely applied by states according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

In the decade after Rio, the Precautionary Principle was often identified as an emerging principle of international law. For example:

- The Maastricht Treaty of 1994, establishing the European Union, named the Precautionary Principle as a guide to EU environment and health policy, along with the principles of preventing pollution at source and that the polluter shall pay.

- The Precautionary Principle was the basis for arguments in a 1995 International Court of Justice case on French nuclear testing (Order 22 IX 95). Judges cited the "consensus flowing from Rio" and the fact that the Precautionary Principle was "gaining increasing support as part of the international law of the environment."

- At the World Trade Organization in the late 1990s, the European Union invoked the Precautionary Principle in cases involving imports of hormone-fed beef and genetically modified organisms.

B. Enforceable measure

In international environmental agreements of the 1980s and 1990s, the Precautionary Principle took the form of a general directive or guiding principle. However, two treaties negotiated in 2000 incorporated the Precautionary Principle for the first time as an enforceable measure:

- The Cartagena Protocol on Biosafety allows countries to invoke the Precautionary Principle in decisions on admitting imports of genetically modified organisms.

- The Stockholm Convention on Persistent Organic Pollutants prescribes the Precautionary Principle as a standard for adding chemicals to the original list of 12 that are banned by the treaty.

C. The Precautionary Principle in national policies

"Precautionary principle" is a translation of *Vorsorgeprinzip*, a fundamental principle of German environmental law and policy developed in the 1970s in response to growing public concern about possible links among power plant emissions, acid rain, and the rapid destruction of the Black Forest. The German public favored *preventive* measures to protect the country's embattled environment, as well as the rapid development of *new technologies* that would build an economically sound, environmentally sustainable future for the country. (von Moltke 1988) *Vorsorge* means, literally, "forecaring." It carries the sense of foresight and preparation—not merely "caution." It has been the foundation of Germany's development as a leader in environmental technologies.

Similar principles, including substitution for hazardous materials, have long guided national policies in Sweden and Denmark. After Rio, many other countries, including Australia, New Zealand, India, UK, and the Netherlands, began basing legislation and policy on the Precautionary Principle and occasionally invoking it in court judgments.

D. The Precautionary Principle in the United States

The United States has endorsed international agreements that contain the Precautionary Principle—for example, the Ozone Treaty and other environmental protocols, the 1992 Rio Declaration (signed by the first President Bush), and the Stockholm Convention on Persistent Organic Pollutants (endorsed in 2001 by President George W. Bush). In addition:

- Since 1978, the International Joint Commission, a monitoring body recommending U.S. and Canadian policy on transborder issues, has called for total elimination of discharges into the Great Lakes of persistent and bioaccumulative substances. In its seventh biennial report in 1994, the Commission said: "Precaution in the introduction and continued use of chemical substances in commerce is a basic underpinning of the proposed virtual elimination strategy." (IJC 1994)

- In 1996, the President's Council on Sustainable Development recommended that "even in the face of scientific uncertainty, society should take reasonable actions to avert risks where the potential harm to human health and the environment is thought to be serious or irreparable." (PCSD 1996)

Precaution is at the basis of some U.S. environmental and food and drug legislation, although the principle is not mentioned by name. These laws incorporate foresight, prevention, and care, and many give regulators authority to take action to prevent possible but unproven harm. For example:

- Under the U.S. Toxic Substances Control Act, the Environmental Protection Agency (EPA) may halt the marketing of a new substance and require safety testing or other measures if the agency determines that the substance may present an unreasonable risk or if exposures are predicted to be significant.

- As a precautionary measure, the Food and Drug Administration requires all new drugs to be tested before they are put on the market.

- Several uses of organophosphate pesticides are to be phased out under the Food Quality and Protection Act of 1996, which requires pesticides to be proven safe for children or removed.

- The National Environmental Policy Act is precautionary in two ways: 1) It emphasizes foresight and attention to consequences by requiring an environmental impact assessment for any federally funded project, and 2) it mandates consideration of alternatives including a "no-action" alternative. NEPA is one of the best national examples of precautionary action.

Other examples of precautionary intent abound. The Wilderness Act sets aside certain areas as nonviolable. The Occupational Safety and Health Act imposes a general duty on

employers to provide safe working conditions and workplaces. The Endangered Species Act sets the overarching goal of protecting biodiversity. The Clean Water Act establishes strict goals to "restore and maintain the chemical, physical, and biological integrity of the nation's waters." The Centers for Disease Control have begun monitoring body burdens of a wide variety of substances, providing important data for future precautionary policies (CDC 2003).

Unfortunately, precautionary action has been the exception rather than the rule in U.S. environmental policy. Instead, even laws with precautionary intent and substance have been undermined, overriden, and poorly enforced. For example, OSHA has too few inspectors for adequate enforcement, and the Endangered Species Act is triggered only in a crisis, after major harm has occurred.

E. Other supporting legal concepts

Besides these laws and policies, at least two other strands of US law support precautionary action.

Right-to-know laws facilitate transparency in decision making, a key component in implementing the Precautionary Principle. For example:

- The Toxics Release Inventory, a publicly available EPA database, contains information on some toxic chemical releases and other waste management activities reported annually by certain covered industry groups as well as federal facilities.

- Labeling requirements for pesticides, foods, drugs, and other consumables provide a great deal of information that is useful to the public for evaluating potential risks.

Broadening the enforcement and requirements of such laws—listing inert ingredients in pesticides and all ingredients in cosmetics, for example—would further implement the Precautionary Principle.

Public Trust Doctrine is a precept of Common Law recognized by state courts in the United States. Under Public Trust Doctrine, states hold certain natural resources to be preserved for the public and future generations. For example, the California Supreme Court in 1983 defined the public trust as "an affirmation of the duty of the state to protect the people's common heritage in the streams, lakes, and tidelands."

The Precautionary Principle and Public Trust Doctrine share the same ethical underpinning—protection of the public good. Public Trust Doctrine gives the state a *duty* to protect certain natural resources for the greater good. The Precautionary Principle and the tools of its implementation provide *means* for carrying out that duty.

F. The Precautionary Principle in states and localities

The Precautionary Principle was introduced to public discourse in the United States in 1998, after a conference at Wingspread in Racine, Wisconsin, which issued the statement quoted at the beginning of this document. That statement was the first to combine the principle of acting to prevent harm in the absence of full scientific certainty with primary ways to implement the principle—democratic processes, alternatives assessment; burden shifting, and goal-setting (see section III). (Raffensperger and Tickner 1999)

Since then, communities and government bodies have begun to consider and incorporate the Precautionary Principle explicitly in state and local policies, laws, and ordinances. For example:

- A bill has been introduced to the Massachusetts legislature calling for subtitutions for 10 toxic chemicals, where alternatives are available, based on the Precautionary Principle.

- A bill is being drafted for the New York State legislature applying the Precautionary Principle to state-funded research on new technologies.

- The Minnesota Department of Public Health has adopted an early warning system on public and environmental health problems, citing the Precautionary Principle.

- The Los Angeles School District has adopted an Integrated Pest Management program, citing the Precautionary Principle.

- Amherst, Massachusetts has a board of health regulation requiring use of the least toxic cleaning chemicals and other products, based on the precautionary principle.

- A number of municipalities, from Denton, Texas, to Hudson, Quebec, have initiated public discussion, ordinances, policies, and plans around the Precautionary Principle.

F. Precautionary laws in California

Several California laws embody precautionary intent although, like national and international laws and policies, they have often been interpreted and enforced in less-than-precautionary ways.

1) California Environmental Quality Act 1970

In 1970 the state legislature passed the California Environmental Quality Act (CEQA), an excellent example of precautionary legislation. CEQA's major goal is to protect and maintain a quality environment for the present and the future. CEQA requires the proponent of any project requiring approval from a public agency to determine whether the project will have significant environmental impacts, and may require the preparation of an Environmental Impact Report on significant adverse impacts of the project, along

with feasible alternatives or measures (including a "no project" alternative) that minimize or remove those effects. CEQA includes a public process.

2) Proposition 65—Safe Drinking Water and Toxic Enforcement Act of 1986

Proposition 65, enacted by voter initiative in 1986, requires a business to give a specifically worded warning for direct environmental and occupational exposures to their products or emissions when the product or emissions contain a chemical that is known to cause cancer or reproductive toxicity. Proposition 65 also prohibits the discharge of these chemicals to drinking water. The warning requirement gives consumers, workers, and others the chance to make a choice about their purchases and activities. The requirement to give a warning was designed to serve as an incentive to industry to reformulate products or cease the release or emission and thus avoid having to give the warning. Proposition 65 also has a citizen suit provision, which allows members of the public to take legal action to enforce the law when the government fails to do so.

G. Precautionary precedents in San Francisco

The Precautionary Principle is a unifying concept that supports many policies already established in San Francisco. Included below are examples of City ordinances enacted to protect human health and the environment and insert an alternatives approach to decision making. (See the Appendix "Resolutions Adopted/Proposed by the Commission on the Environment" for relevant resolutions adopted by both the Commission and the Board of Supervisors.)

- The Resource Conservation Ordinance was adopted in 1992 to impose certain requirements upon City departments to recycle and reduce the amount of waste they generate. The ordinance was amended in 2000 to require City departments to develop Resource Conservation Plans, make City departments accountable for reducing waste, and to add buy-recycled provisions.

- The City of San Francisco is pioneering environmentally sound ways to manage urban pests and protect public health and the environment, through its integrated pest management program (IPM). The IPM Ordinance, passed in 1996, mandates that San Francisco eliminate the use of the most toxic pesticides and use only chemical pesticides from an approved list of reduced risk pesticides.

- San Francisco was one of the first cities to enact a resource-efficient building ordinance, adopted in July 1999, which requires standards of resource efficiency in all city buildings and calls for a series of pilot projects to demonstrate state-of-the-art green building technology. Such technology promotes maximum efficiency in energy and resource use with minimum negative impacts on the environment and human health.

- In 1999, the City and County of San Francisco adopted an Environmentally Preferable Purchasing Ordinance with the goal of reducing the health and

environmental impact of products used in its operations. (This program is currently limited in scope.)

- In 2002 San Francisco became the first city in the country to ban the use of arsenic treated wood in all City construction projects. The Pressure Treated Wood Containing Arsenic Ordinance requires City departments to select less toxic alternatives when using pressure treated wood in buildings, parks, or piers.

- The Urban Forest Council Ordinance, adopted in 2001, guides the stewardship of San Francisco's trees by promoting a healthy and sustainable urban forest that benefits all San Franciscans while ensuring public health and safety. The Council's mission is to protect the community interest and ensure that San Francisco realizes the full range of tree benefits into the future.

- Less than twenty percent of the earth's original forests are still standing—and in the U.S., less than four percent. The City's ban on purchasing tropical hardwoods and virgin redwood protects is designed to reduce demand for wood from our last remaining old-growth forests in favor of sustainable alternatives.

- In June 1999, the Board of Supervisors unanimously passed a resolution urging all City agencies and departments and all medical facilities within San Francisco to eliminate mercury use in order to protect and preserve human and environmental health. This was followed by an ordinance banning the sale of mercury thermometers within the City and County of San Francisco.

III. Precaution as an organizing principle

Local and regional precautionary initiatives are at an early stage. San Francisco's adoption of an environment code incorporating the Precautionary Principle, along with specific implementation policies, will serve as a model to other localities on how to use precaution as a unifying principle for environmental policy. The principle is most powerful when it serves this way, as an overarching guide.

The primary idea embodied in the Precautionary Principle is vigilance against *harm*, which in turn prompts timely *action*, even in the face of scientific *uncertainty*. But that alone does not translate into sound policies protective of the environment and human health. Certain processes and norms, exemplified in many of the above examples, support its implementation. They are interwoven.

A. Democracy and transparency

Taking preventive action against harm means that someone has to decide what constitutes harm. Such decisions, which are ethical and political, should include those who might suffer that harm. Thus, transparency (openness and accountability) and some form of participatory decision-making are important.

B. Science to support precautionary decision making

Society, not science, is the ultimate arbiter of policy, but good science is essential to precautionary policy. Some characteristics of precautionary science are the following:

- Preventive action in the face of uncertainty requires acknowledging scientific uncertainty. This is also essential to transparent, democratic decision-making.

- Precautionary science, like democratic processes, relies on gathering and using information from as many sources as possible.

- The Precautionary Principle encourages scientific investigations of complex systems, their interactions, and consequences.

- It places a high value on monitoring environmental conditions and changes, on reporting early warnings of harm, and on careful tracking of effects of technologies, projects, and products.

- The Precautionary Principle supports innovation in ecologically sound technologies (Ackerman and Massey 2002).

C. Alternatives assessment

If the need for a possibly harmful product or technology is questionable, or if safer alternatives are available, society must be able to choose those better alternatives. Evaluating a single proposal or technology on its own merits raises a narrow set of questions on harm: whether or not the action might have harmful effects, how harmful it might be, and how much harm can be tolerated. These questions lead easily to the conclusion that any activity must be tolerated unless harm can be demonstrated with a high degree of certainty. The essence of risk assessment is, "How much harm can we tolerate?" The essence of alternatives assessment is, "How much harm can we avoid?" The simple act of *comparison* raises new sets of questions:

- If there are alternatives, is this one necessary?
- Why are we doing this?
- Is this the best way?
- Who benefits from the various alternatives?
- Who pays or suffers harm?
- In light of alternatives, how can we avoid or mitigate harm?
- In light of new science, should current practices be reevaluated?

As we develop more opportunities to assess alternatives, as San Francisco has done in its Environmentally Preferable Purchasing and Integrated Pest Management programs, society is trapped less often into dealing with harmful technologies after the fact. Assessing alternatives means not only choosing the best among similar options—for example, the least harmful pesticide—but stepping back and looking at bigger questions:

How do we grow the safest, most nutritious food? What are the landscape alternatives to water- and pesticide-dependent lawns? Alternatives assessment encourages the development of environmentally sustainable processes and technologies.

D. Burden shifting

Preventive action is impossible if technologies and practices are routinely assumed to be "innocent until proven guilty" of harmful side effects. Such assumptions often allow irreversible harm to occur before action is taken. Producers and proponents therefore must bear the burden of demonstrating and maintaining safety of products, projects, and technologies. Conducting business with transparency and full disclosure of product ingredients are also important parts of this responsibility.

E. Goals

Goal-setting is an important precautionary mechanism. When a goal is set, actions must change on many fronts to meet it. Goals place appropriate responsibility on producers, users, and participants in products, technologies, and projects—including governments and citizens—and hold everyone accountable without undue scrutiny or micromanagement. Goal-setting is the main leverage behind international agreements and negotiations such as the phase-out of chlorofluorocarbons (CFCs) and the effort to avert global warming. Sweden has set the goal of eliminating *all* persistent organic pollutants in breast milk, regardless of whether they have been proved to have caused harm.

In California, reducing body burdens of synthetic chemicals found through biomonitoring or reducing the incidence of asthma or cancer would be possible goals requiring precautionary policies.

F. Other precautionary opportunities

Good precautionary policy is based on all of these elements, but many policies and actions implement some of these elements, to some degree. So long as overall policy is guided by goals supporting human and environmental health and wellbeing and by the ethics of responsibility and care, a wide range of actions may qualify as precautionary.

Precaution does not work if it is only a last resort. Any number of positive and nuanced actions can and should be taken at many points during the development of technologies, processes, and practices that would eliminate the need for bans and moratoriums. Clean production—minimizing waste, eliminating use as well as release of toxic substances—has always been at the top of a precautionary agenda.

The Precautionary Principle opens the door to many possible actions, laws, and policies that contribute to preventing harm to humans and the environment, learning more about the consequences of actions, and acting appropriately. The principle is a guide to making wiser decisions in the face of uncertainty.

IV. Precaution and economics

"How much will it cost to implement the Precautionary Principle, and can we afford it?" are legitimate questions for taxpayers and policy makers alike. Like precautionary science, precautionary economics operates in the real world, in which connections, costs, and benefits are complex and surrounded by uncertainty. Tallying the "cost" of precaution requires making true *value* judgments, which can only partially be expressed in monetary terms. (See Ackerman and Massey 2002.)

A. Allocating responsibility

The price tags on most products and technologies fail to represent their full costs in either monetary or nonmonetary terms. Methods have been developed to better account for real costs and to distribute costs and benefits more fairly. Three concepts may be particularly useful.

1) Negative externalities

Negative externalities refer to harm (economic, health, social, cultural, and so forth) created when individuals or organizations take actions that benefit themselves while forcing some of the costs onto others. When a negative externality is present, the full cost of a product is invisible to producers and consumers. For example, if a manufacturer disposes of toxic waste in a local river, costs are imposed on people who use that river for drinking water, swimming, or fishing. However, that cost is not reflected in the price of the goods that manufacturer sells. In order for producers and consumers to make good decisions about how much of a good to buy or sell, the costs imposed on the river system and its users—such as illness, species decimation, or loss of habitat, livelihood, or access—must be built into the cost of the good.

Accounting for, or internalizing, negative externalities means shifting the costs back onto those who benefit, insofar as possible. This is the "polluter pays" principle. The concept of negative externalities is important in environmental policies, such as the European Union's policy on transportation. In EU Bulletin 1.2.127 (1997), the EU explicitly adopts the approach of "internalizing the external costs of transport as a step towards developing sustainable mobility." A number of European countries have initiated "green taxes" to internalize costs. For example, the Dutch Water Boards require polluting industries to pay a tax based on units of pollution emitted—including mercury, cadmium, copper, lead and arsenic. This raises the price of polluting products and technologies and creates a market incentive to reduce pollution emissions.

2) Life Cycle Analysis

Most current production technology is incompatible with the finite nature of earth's natural resources. Resources are extracted and consumed unsustainably, processed inefficiently, and made into products that are often discarded as waste. The use of toxic materials such as mercury, asbestos, lead, or chlorine-based chemicals in production

processes can result in dangerous emissions, by-products, and ingredients in final products.

An environmental Life Cycle Analysis (LCA) is a tool that can help to quantify how much energy and raw material are used and how much waste is generated at each stage of a product's life. Life Cycle Analysis is an emerging discipline, with guides published by institutions such as the Society of Environmental Toxicology and Chemistry and the U.S. Environmental Protection Agency.

Life Cycle Analysis, like other numerical tools, is subject to manipulation if the intent is to hide rather than reveal costs. Ideally, LCA should also look at health and environmental impacts and bring them into the analysis, but this is rare because it is difficult to assign numbers to these factors. It is best practiced in the context of a full range of precautionary policies such as "extended producer responsibility," whereby producers bear legal, physical, or economic responsibility for the environmental impacts of their products that cannot be eliminated by design. Extended producer responsibility provides incentives to producers to prevent pollution and reduce resource and energy use in each stage of the product life cycle, including a plan for disposal. Another related concept is lifecycle accounting, which calculates whether goods that are relatively expensive to purchase and install may turn out to save money over the longer term, due to lower maintenance, repair, or replacement costs.

3) Performance bonds

The concept behind bottle deposits is simple: to encourage consumers to dispose of the bottle in the most desirable way (recycling) and to help cover the cost if they do not. Performance bonds apply a similar concept in construction and mining projects. Bonds paid by strip miners of public lands, for example, are returned only after the land is restored. Environmental bonding could be developed more broadly and used to assure that developers of new technologies or others seeking to use society's resources are held financially responsible for any potentially damaging activity. (Cornwall and Costanza 2000)

B. The magnitude of costs and savings

Recognizing negative externalities and using Life Cycle Analysis and performance bonds would help to shift the burden of responsibility appropriately, an important aspect of precautionary policy. However, even at their best, these tools are inexact ways to account for the true "bottom line" of either precautionary action or the failure to act with precaution. That is because "costs" involve incalculable values such as life, health, and the future of our descendents and fellow species. However, it is useful to remind ourselves of the magnitude of the costs of *failing* to act with precaution, in both monetary and nonmonetary terms. Here are some examples in which specific calculations have been made:

- Infante and Distazio estimated in1988 that the 10-year delay in setting the risk-assessment-based benzene standard will eventually be responsible for an additional 198 leukemia deaths and 77 deaths from multiple myeloma among exposed US workers. (EEA 2001)

- A Dutch calculation estimated that if the Netherlands had banned asbestos in 1965, when the evidence first suggested a link with mesothelioma, instead of in 1993, the country would have been spared 34,000 victims and 41 billion guilders (about $20 billion) in building and compensation costs. (EEA 2001)

- A new policy on chemicals in the EU would require thorough testing of all existing chemicals, at a cost to manufacturers of 2.1 billion euros over 11 years, in order to "reduce the incidence of certain diseases related to chemicals (such as cancer or allergies) and reduce the risks that chemicals can pose to the environment." The authors of the policy acknowledge that "neither the dangerous properties nor the uses of chemicals are sufficiently known," but they point out that allergy costs are about 29 billion euros per year in Europe and that asthma cases have risen by 40 percent since the 1970s. "If the new strategy makes even a small reduction in the 29 billion of allergy costs, this will outweigh the costs of the strategy," they conclude. (EC 2001)

- The Massachusetts Toxics Use Reduction Act (TURA) requires manufacturing firms to account for chemical use and to develop plans to reduce toxic waste, emissions, and use. From 1990 to 1999, companies reduced chemical waste by 57 percent, the use of toxic chemicals by 40 percent, and chemical emissions by 80 percent *while saving $15 million.* This figure does not include non-quantifiable health, safety, and environmental benefits (Ackerman and Massey 2002; see also www.turi.org).

C. The Precautionary Principle in business

Increasingly private-sector research, product development, and business practices are implicitly or explicitly being harmonized with the Precautionary Principle.

- Rigorous pre-market testing, clean production and waste reduction programs, and certification programs such as the ISO series support a precautionary approach.

- Guides such as The Natural Step (for sustainable enterprise), the Hannover Principles (for building and architecture), and the Principles of Green Chemistry direct enterprises to the ethics and science of precaution. Whole new industries are arising around the principles of sustainability.

Several corporations have explicitly invoked the Precautionary Principle in specific policies:

- In June 2001, citing the Precautionary Principle, Verizon issued a warning against

excess cell phone use by children.

- Bristol-Myers Squibb has adopted this guiding statement for the company's research: "Scientific uncertainty alone should not preclude efforts to address serious environmental, health, and safety threats." Based on this principle, the company has developed a scorecard for evaluating processes to address these threats, and it seeks to minimize concentrations of pharmaceuticals in the environment. (BMS)

In addition, corporations often modify products and processes voluntarily to avoid harm on the basis of early warnings, when the science is still uncertain. Recently, for example, a number of companies stopped using some members of a class of chemicals called phthalates in toys, cosmetics, and some medical equipment and are developing alternates for these uses. Concerns center around evidence that these chemicals are absorbed in human bodies and that some have been associated, in animal studies, with developmental and reproductive disorders and other damage.

As public awareness grows of hazards and of safer alternatives, these practices represent not only good ethics but smart business. The markets of the Twenty-First Century will increasingly demand safe products and sustainable technologies.

D. Precaution and jobs

In *Prospering with Precaution*, Ackerman and Massey (2002) dispel myths that strong environmental policies weaken economies and cause job loss. Among their findings are the following:

- A number of environmentally protective practices, such as recycling, create more jobs than environmentally harmful practices such as landfilling. Environmental jobs are firmly rooted in the local economy;

- Environmental spending (much like defense spending) creates proportionally more skilled industrial jobs in the private sector and fewer government jobs;

- Environmental regulations do not create mass worker layoffs. According to the Bureau of Labor Statistics, only one in 1,000 layoffs annually might be attributed to such regulation. On the other hand, environmental protection creates many more jobs annually, for a net increase.

- Environmental regulations do not drive companies to relocate to less-regulated countries. The costs of environmental regulation are small—hardly ever as much as 2–3 percent of a company's sales revenue. Other factors such as wages and markets are the major reasons for relocation.

Precautionary policies support the economics of the present and future—rapid development in the environmentally sound business sector and appropriate spending in

the present for immediate and longer-term gains in human and environmental wellbeing as well as productivity. The Precautionary Principle does not challenge the need for economic development—that is part of what is necessary for human survival—but it reminds us insistently of our larger responsibility. It causes us to ask more questions about what we are doing, and why, and what the consequences will be. It harnesses the best tools of human knowledge (especially scientific knowledge) and action (including technology) to the ethic of responsibility.

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The Department of the Environment would like to give special thanks to Nancy Myers of the Science and Environmental Health Network for her excellent input on this document. We were also grateful for the thoughtful and articulate comments from: Francesca Vietor and Davis Baltz, Commonweal; Tim Shestek, American Chemistry Council; Lena Brook, Clean Water Action/Clean Water Fund; Neil Gendel, Healthy Children Organizing Project; Tom Lent, Healthy Building Network; Janet Nudelman, The Breast Cancer Fund; Rachel Massey, Global Development and Environment Institute, Tufts University; Joan Reinhardt Reiss, The Breast Cancer Fund; Rona Sandler, City Attorney's Office, San Francisco; Katie Silberman, Center for Environmental Health; Joel A. Tickner, Lowell Center for Sustainable Production, University of Massachusetts.