CHAPTER 1

CONCLUSIONS AND RECOMMENDATIONS

The mandate of the National Commission on Materials Policy (under Title II of the Resource Recovery Act of 1970) is "to enhance environmental quality and conserve materials by developing a national materials policy to utilize present resources and technology more efficiently, to anticipate the future materials requirements of the nation and the world, and to make recommendations on the supply, use, recovery and disposal of materials."

A national materials policy must start with recognition that materials, energy, land and water, population, environmental degradation, and pollution constitute a web of intersecting elements, none of which can be viewed in isolation. Moreover, the web ignores national boundaries as materials move over the land, through the atmosphere, and in the waters of land and sea. A national materials policy is, therefore, a single element of the larger task of conserving the earth for the sustenance of man's physical, mental, emotional, and social well-being.

A national materials policy must furthermore take into account that governments everywhere begin to accept the concept of "Only One Earth" as a new determinant in the making of national policy. The United Nations Conference on the Human Environment held at Stockholm in 1972 declared that

> A point has been reached in history when we must shape our actions throughout the world with a more prudent care for their environmental consequences.

The conference charged the nations assembled there: to safeguard the natural resources of the earth and, to that end, to maintain, restore or improve the capacity of the earth to produce renewable materials, and in employing the nonrenewable resources of the earth to guard against the danger of future exhaustion. It is within this complex of changing international attitudes and values that domestic materials policy should be fashioned.

The study committee believes that the charge to the National Commission on Materials Policy can and must be met. The committee believes that in meeting this charge the United States will be confronted by decisions of utmost gravity, decisions that certain other countries must face as well.

If we extrapolate over the next thirty or forty years, the view commonly held in the United States that two cars in the garage mean a better level of living than one will increasingly collide with our interest in protecting the health and well-being of our fellow citizens.

Given the present level of technology and what may reasonably be expected to evolve over the next decades, and given the prevailing view that materials consumption is the way to a better life, the facts indicate (1) materials throughput will double, and then double again, over the next thirty or forty years, (2) the quality of ores and other natural resources will decline and readily available sources be exhausted, (3) only by increased use of energy per unit of output and per capita will the intensity of materials throughput be maintained, and (4) the environmental stress per unit of production will increase correspondingly.

Given the growth in population, the growth in per capita product, and the growth in environmental stress per unit of product implied by sustained movement on our present track, the environmental ills presaged for the United States cannot be completely avoided by available technology.

The study committee believes that the threat to environmental quality and resource availability, caused and compounded by our treatment and use of materials, poses a real problem and a vital national issue which calls urgently for an open-minded reexamination of certain commonly held beliefs. These beliefs are : (1) that natural resources can be used in whatever amount is evoked by public demand for goods and services as stimulated and guided by producers' efforts to enlarge their markets; (2) that improved well-being of society is adequately measured by aggregate volume of the production of goods, increased per capita use of goods, and aggregate consumption of materials and energy; and (3) that technological development should and will continue to contribute to and accelerate the increased throughput of materials per person as it has in the past.

The committee recognizes that dissents to these commonly held beliefs can be found, but they constitute a relatively small voice within the prevailing views of consumers, business, labor, and governments. First corrective steps have been taken by the Congress and other legislative bodies, but without full recognition of the profound change in values that is called for: a clear assertion of each person's right to an environment that is not only healthful but possesses a beauty that reflects regard for and insistent action to cherish and perserve its natural qualities.

This right must be given full status with other basic assumptions by the nation as it seeks to provide for the physical health, intellectual growth, economic and social well-being, and security of all citizens. The study committee believes that consideration of environmental costs should be anchored in all relevant national policies and laws having as their objective the conservation or development of any sector of the national economy, including renewable and nonrenewable materials. The study committee recognizes that there are a number of laws designed to bring a balanced consideration of environmental values with economic and social objectives. In particular, the National Environmental Policy Act of 1969, in Sec. 101, addresses the crucial conflict which we have identified: material abundance vs. environmental quality. In addition, major pollutant control laws such as the Clean Air Act Amendments of 1970, the Federal Water Pollution Control Act Amendments of 1972, and the Noise Control Act of 1972 all include strong provisions for citizen suits. These laws have been enacted only recently; their success in redirecting public policy is yet unknown; they must be strongly supported by all sectors of society.

After a reasonable period of time, if administration and adjudication of these laws do not produce the necessary readjustment, an additional anchoring of the principles of environmental protection in the fundamental law of the land may be necessary. To this end we recommend the examination of the need for and the development of both an amendment to the National Environmental Policy Act of 1969 and to the Constitution of the United States declaring that the right of an individual citizen to a safe, healthful, productive, and aesthetically and culturally pleasing environment shall not be abridged.

The proposed amendment or its legislative counterpart is based on the assumption that the nation is capable of a measured and gradual transformation of its production machinery, away from concentration on scarce materials and on accelerated use of energy, and of adjustment to standards set by our new environmental policies. These changes in production do not imply loss of economic revenue or employment, although there may be considerable shifts within the labor market. On the contrary, the promotion of economic growth in sectors selected because of low risk of environmental disruption, will safeguard the economic substance of the nation and, in the long run, enhance the quality of life. Discrimination and restraint in the use of critical materials coupled with intensified efforts to recycle or to substitute materials in short supply, will in the long run diminish our dependence on foreign resources, reduce the volume of imports and prevent escalation of economic competition with other nations for scarce materials.

The study committee assumed that a materials policy designed to protect the environment will be accompanied by a compatible population policy. Population pressures being a factor contributing significantly to our environmental problems, a population policy would seem to be essential, if indeed not an indispensable complement of policies, such as a materials policy, dealing with other urgent environmental problems. The fact that the committee does not address itself to population thus is not an indication that the topic is of less importance but only that it falls beyond the committee's mission.

The committee reached nine additional conclusions of immediate concern to the national leadership:

1. A revised policy on materials will require the use of a wide variety of instruments and proposed innovations in government administration: taxes; environmental standards; standards of behavior and design; pricing and output regulations; licenses and permits; leasing conditions on public lands; and education and persuasion. The application of these instruments of policy, alternatively or cumulatively, should be decided solely on grounds of the merits and effectiveness of each.

2. Economic growth should be guided along a path consistent with policies designed to improve the environment. Sectors that impose minimum stress on the environment should be encouraged, those that impose severe stress should be discouraged. This guidance is achieved in part by the practices described in paragraphs #3 and #4, below, but additional steps are needed as well. Such steps will have to include a deliberate redirection, using and augmenting the market system, of the nation's productive capacity as well as a prudent, selective redirection of certain categories of demand. The net effect of such guidance will be to give

durability preference over planned obsolescence, to stimulate use of materials and production methods that facilitate recycling, and to stimulate interest in sources of satisfaction that reduce environmental stress. Educational and public information programs should be used much more generously than at present.

3. A national materials policy must incorporate the principle that environmental costs, measured as the aggregate of social losses suffered as a consequence of impairment of the environment, are taken into account in the computation of benefits and costs of any action to extract, transport, process, use, or dispose of any material. In order to evaluate all environmental costs, especially those that are inadequately reflected in market prices, a practice of full disclosure of the environmental effects of private as well as public activity should be mandatory. The approach taken by the National Environmental Policy Act of 1969 and the Technology Assessment Act of 1972 should be broadened, strengthened, and applied to all stages in the flow of materials through the economy.

4. Although some exceptions might occasionally be justified, efficiency in the use of materials is most likely to be achieved when the costs of environmental damage are borne by those who are responsible for the impairment. Costs are to be charged to those who contribute to environmental damage by the levying of taxes, fines or other penalties, or by otherwise enforcing compliance with an environmental or design standard.

5. When environmental effects are taken fully into account certain uses of materials will be perceived as yielding benefits that are trivial in comparison with their costs. This realization will be amplified by recognition of the finite dimension of a high quality environment and anticipation of the growth in its value relative to other things.

6. Land use planning and the imaginative and discriminating use of a variety of devices, including appropriate incentives, are essential instruments for a policy designed to protect the quality of the atmosphere, rivers, lakes, coastal zones and oceans, as well as the land; and are also essential in the formulation of an energy policy which, in turn, is a major component of a national policy. Such land use planning must also take account of the need to relieve congestion in megalopoles, and to foster the spread of community development adapted to sound environmental standards.

7. In fulfilling the international and global obligations that go with a national materials policy the United States should take the initiative in adopting the best available practices, in stimulating the attention of others to environmental problems, in providing technological assistance to the best of its ability, and in joining with other nations in agreements to protect the air, the seas, the world's pool of genetic materials, and important landmarks and treasures of civilization that are threatened by environmental decay. In adjusting to the measures taken in this and other countries to protect the environment, the United States should not tolerate a growth in protectionist trade policies, to the detriment of its own and the world's efficient use of scarce resources.

8. As far as compatible with the national interest, the United States should embark without delay on a course that will steer clear of collision with other industrial powers bidding for environmentally attractive resources in short supply, such as low sulfur petroleum and liquid natural gas. It should seek jointly with major producers and consumers corrective multilateral solutions providing for orderly and equitable marketing arrangements and, at the same time, intensify the development of new technologies to ensure availability of needed resources.

9. The present state of knowledge about the origins and effects of environmental deterioration is so incomplete that it is impossible to assert with certainty how close or remote a crisis may be. In recognition of the complex forces that drive the ecosystems of the world, the committee urges the allocation of funds for expansion of research with all deliberate speed, immediate adoption of a broad program for the acquisition of base-line data, and creation of national and international machinery for adequate monitoring of environmental parameters, including effects on the ecosystem.

The committee recognizes that the environments of open spaces as well as those of cities are endangered. In the countryside, the effects of materials flows on human health are likely to be less than on the deterioration of natural habitat, degradation of the landscape, clouding of the atmosphere, and litter. As cities sprawl outward, linked by an increasingly complex network of interstate highways, prime agricultural land is preempted, reducing agricultural productivity in greater proportion than is indicated by the relative shift in land use. As a consequence of the shift in land use, use of fertilizer and other on-the-farm materials is increased without a corresponding increase in output. Within the cities, especially the megalopoles, the cumulative, often synergistic environmental impacts of materials use from automobiles, trucks, buses, power plants, factories, and heavy construction threaten human life, obliterate vegetation, and destroy many of the amenities of urban living. The aggregation of effects in concentrated areas provoke the environmental question asked by President Nixon in his State of the Union message of 1970:

> In the next 10 years we shall increase our wealth by 50 percent. The profound question is--does this mean we will be 50 percent richer in a real sense, 50 percent better off, 50 percent happier? Or does it mean that in the year 1980 the President standing in this place will look back on a decade in which 70 percent of our people lived in metropolitan areas choked by traffic, suffocated by smog, poisoned by water, deafened by noise and terrorized by crime?

Environmental damage not only affects the physical-biological realm but creates serious socio-economic problems as well. There is evidence that those who are poor suffer more from environmental degradation than those who are rich. Loss of environmental quality, therefore, accentuates the inequality of income distribution and aggravates the problems of poverty in the countryside as well as in the urban ghetto.

* * *

The conclusion that a materials policy can give due regard to the environment is based upon findings taken from succeeding chapters, supplemented by appreciation of the tradition of adaptability revealed by our nation's history:

> While we have not yet explored the full range of adjustments of which we are capable, we know that our economic system possesses flexibility and unused capacity:
>
> -- for many materials there are substitutes in each of their uses;
>
> -- certain major materials such as lumber, coal, and petroleum, are available from various sources, exploitation of which imposes a range of stresses from relatively little to relatively great;
>
> -- the assortment of goods and services for consumption can be changed by prudent cuts in, or shifts from, consumption of environmentally degrading goods and services to others that are less damaging;
>
> -- domestic as well as international economic impacts of environmental protective policies can be borne by adjustments in exchange rates, fiscal policies, monetary policies, trade patterns, and consumer preferences.

Present and new technologies, if properly applied and fully exploited, will go far toward relieving present environmental stress. Institutions and instruments of social control, such as taxes, prohibitions, licenses, etc., are available to implement remedial actions.

These factors permit the hope that given the attention and priority urged by the committee there is time to adopt suitable practices that are now available, and to develop others not now known before further serious shortages of materials and irreversible degradation of the environment occur.

The presence of favorable factors does not diminish but enhances the urgency for timely action. Yet, unfortunately there are reasons to believe that we have underestimated the need for prompt action.

> Many environmental hazards are only dimly visible at this time. There is still a great deal we do not know about the interaction among materials uses, the environment, the ecosystem, and man.
>
> Biologically and geologically, as measured against the yardstick of natural processes, man has become a force to be reckoned with, not merely locally but regionally and in some cases globally. This already unprecedented absolute impact may be doubling as rapidly as every fifteen to twenty years, justifying cause for concern: corrective action may come too slowly to avert much graver environmental degradation than has already occurred.
>
> At least three factors are operating to make it possible, even likely, that some environmental disruption will be experienced as sudden catastrophe rather than as a slowly moving and predictably growing shadow. One is the long time lag that often intervenes between an environmental insult and the appearance of harm--e.g., carcinogens and mutagens. The second factor is the irreversibility of some kinds of damage--e.g., the loss of genetic variability. The third is the apparent existence of environmental thresholds in some processes, wherein a small increment of some input to the environment generates a disproportionate response--e.g., triggering of climatic change by natural processes.
>
> Many foreseeable problems cannot now be solved by available technology. Even if we control 99.5% of some pollutants, the remaining one-half of one percent, because of large absolute amounts projected by the year 2000, can create environmental problems for which a workable remedy has not yet emerged from the laboratory. An example is the difficulty of removing very small particles from flue gas.
>
> Most people are not aware of the dangers to local, national and world well-being created by environmental

stresses. Most people, moreover, are unaware of the kinds of choices available to them in conducting their affairs so that environmental stress is minimized. Unless the perception of environmental action is sharpened and acceptance of remedial action is increased, we may suffer unwanted irreversible environmental damage.

A materials policy that gives due regard to the environment will manifest itself in a number of ways:

Explicit attention will be given to environmental management at every stage of the materials throughput, thus changing many decisions and actions from what they have been in the absence of such attention.

A growing portion of materials and other resources will be dedicated to improving the environment. The assignment of resources to protect and improve the nation's great natural and cultural inheritance will measurably improve the quality of life for its citizens. The careful restoration of the countryside or urban areas, the provision of adequate housing, of educational and recreational facilities, and different modes of transportation could alter the nation's bill of goods in a most constructive way.

Some environmental problems, especially those dispersed over wide areas, can be solved only by curtailing or eliminating the use of certain materials. For some materials or commodities an evaluation of net benefits yielded by their use is sufficiently inconclusive to suggest the need for further investigation. We know enough about other materials, however, to recognize that we should reduce or eliminate their use as quickly as possible.

When environmental effects are taken fully into account, practices now taken for granted are likely to be reexamined. There is clear evidence that certain practices related to product novelty, obsolescence and packaging, impose environmental burdens excessive relative to the marginal benefits they yield. The use of energy in housing, production and transportation must be assessed against environmental and other costs. The automobile with all of its contributions to American society must be examined from an environmental perspective and its advantages weighed against those of modern economical mass transit systems.

All resources of private as well as public sectors will be mobilized to accomplish the education required to effect the changed view of materials use that is needed.

To hold that every decision, public, or private, regarding materials usage must be made in light of its environmental impact implies, first, a common sensitivity to the quality of the environment; second, general recognition that the quality of the environment is closely related to man's well-being; and, third, common acceptance of the ethical rule that protection of the environment must constrain materials usage. As valuation of environmental quality sharpens and spreads, the desired mix of goods and services will change. Those who themselves put a high value on environmental quality believe that the taste for clean air, a sparkling stream, and an undisturbed hillside sharpens rather than dulls with exposure. Since the supply of natural amenities has been diminishing, the pressure of demand on remaining supply presumably will increase, not only because of population growth but also because of increased perception, justifying intensified policies today to protect natural assets of the future.

* * * * *

The remainder of this chapter is based on and summarizes succeeding chapters; a description of the damages attributable to material flows; remedies and institutions; major recommendations; international considerations, and necessary research.

1.2 Environmental Effects

The environmental effects of materials flows can be described by reference to nine major elements:

1. material: metals, nonmetallic minerals, energy materials, forest and agricultural products, polymers, ceramics, and fibers;

2. stage of the materials cycle: exploration, extraction (harvest), transport, processing, use, recycling, and ultimate disposal;

3. form of environmental disturbance: emission of unwanted substance, disturbance of surface or underground configuration, unwanted dispersal of materials, reduction of ecosystem productivity;

4. environmental medium that is abused: biota, atmosphere, land surface, subsurface land or water, rivers and lakes, coastal zones, oceans;

5. geographic character of the source of the disturbance: point source or dispersed source;

6. geographic character of the effect of the disturbance: migratory or *in situ*; within the transport medium, the sink, or both; local, regional, national, transnational, or global;

7. character of the damage to human welfare: direct assaults on life and health, direct damage to crops and property, sociocultural impact, aesthetics and related components of quality of life, indirect impact through interference with beneficial functions of ecosystems;

8. magnitude or severity, including cumulative and synergistic effects;

9. temporal factors: rate of growth of impact, continuous disruption of discrete incidents, degree of irreversibility.

A materials policy that gives due regard to environmental effects is indeed a complex matter when full account is taken of the number of combinations yielded by these nine categories for all materials, all stages of use, all environmental media, all sources, and all effects.

cf. 3.1.3 7.2

Some materials create environmental changes of a global dimension. Relatively little is known of the magnitude of damage that these changes presage. The discharge of waste heat by manufacturing and power plants (especially over large urban regions), acidification of rainfall, and increased atmospheric burden of carbon dioxide are examples of global disturbances created by the combustion of fossil fuels.

cf. 3.3.3 5.3.5

Phosphorus, which is essential on a global scale for food production, and recyclable only over extremely long periods of time, should be husbanded in the interests of direct and indirect environmental impacts. Directly, improper uses of phosphorus contribute to enrichment of nutrients in water and accelerated rate of eutrophication. Indirectly, the imprudent depletion of high concentration phosphate deposits would lead to increased deterioration as more land is mined for lower quality deposits.

cf. chapters 3, 4, and 5

Some materials in their manipulation by man create offenses at successive points in the flow from extraction through processing to use and disposal. Other products impose an environmental burden at selected points of the materials flow. Gold and silver, for example, impose negligible burdens in their use or ultimate disposal. Coal, lead, mercury, cadmium, and radioactive minerals, however, place environmental burdens at successive stages from extraction to disposal. Timber imposes a burden at the time of harvest, when processed into paper or board, and when cut and planed. Secondary burdens result from the use, reuse and disposal of products. In some instances, the environmental burden is the result of unwanted concentration; e.g., tailings, spoil, slash, saw-dust. In other cases, the environmental burden is the result of

unwanted movement; e.g., atmospheric transport of heavy metals and sulfur, aquatic transport of fertilizers and pesticides, and the disposition of litter.

cf. 3.2 (all sections); 4.3.5; 4.8; 6.2.1; 7.4; 8.4; 8.10.1

1.2.1 Effects on Human Health

Certain environmental effects directly damage the health of man. Mild or acute poisoning, respiratory disease, cardiovascular failure, and cancer can be caused by various materials. In evaluating the effects on health of emissions of materials to the environment in excess of natural levels two essential principles apply:

cf. 3.2.1 3.2.11 cf. 3.2.3

1. In the absence of evidence to the contrary, for a population of various ages and initial states of health, no threshold should be stipulated below which exposure is harmless. Instead, the response to exposure should be assumed to be directly related to successively greater or lesser concentrations of the toxic materials and the level of resistance of those exposed. Those who are most susceptible are affected by concentrations that in the short term appear to be harmless to others. Measurements of mortality or morbidity from exposure to a particular substance may conceal the fact that the measurements are made on a hardy segment of the population.

cf. 3.2.2 3.2.7 3.2.11

2. The concept of total body burden should be the significant indicator of exposure, rather than burden acquired in one or another part of the environment or from one or another toxic material. People who work in a factory in which dangerous substances are handled in high concentration, may live in an adjacent area in which the same or other substances are dispersed, thus increasing overall exposure. More than one organ may be attacked because the offending substance is transported by two or more media. Synergistic effects among two or more substances, by which the combined effect is more than the sum of the separate effects, should be considered. It is recognized, of course, that standards of health and safety may be based on the determination that protective devices may fall short of perfection. Incremental costs may prove too high if compared to the increment in protection that can be achieved.

cf. 3.2.8-11; 4.2.3; 5.3(all sections)

Impairments of the environment may affect man directly through health or aesthetic satisfaction, or indirectly by reduction in the vitality of vegetation and animal life and consequent impairment of the services provided to mankind by natural processes (maintenance of soil fertility, natural pest and disease control, waste disposal, fish and wildlife

production and others). The committee finds that knowledge of the effects of exposure to various emissions is incomplete, as is also the knowledge of other environmental disturbances that move slowly through the physical-biological world. We have relatively little knowledge of the health effects of many substances, especially if contacts are at a low but sustained level and the substance acts slowly.

cf. 2.4.1
3.2.4
3.2.11

1.2.2 Other Environmental Effects

Scientific knowledge of the behavior of temperate forests has grown substantially in recent years but not rapidly enough to eliminate debate regarding the effects of various forestry practices on nutrient cycling, stability of soils, stream runoff, the health of fauna and flora, and capacity for sustained productivity. Knowledge of the behavior of tropical forests is even more deficient, a lack that is especially threatening in light of prospective increase in the exploitation of tropical forests.* Possible changes in climate induced by emissions of heat, gases, and particulate materials have already been mentioned. We may also face the threat of substantial, irreversible changes in the productivity of the coastal zones and oceans, resulting from accelerated deposition of waste materials and excessive harvest of aquatic life.

cf. 5.3 (all sections)
*cf. 5.5 - 5.5.4
cf. 5.3; 6.1; 7.4

Appreciation of environmental effects of materials uses is made difficult by interactions consequent to most decisions. Sulfur emissions can be reduced by making greater use of western domestic coals, but only at the expense of stripping away the land cover in an arid region where recovery is especially slow and requiring more transportation of fuel or extension of power corridors. Motor vehicle emissions of lead from internal combustion engines can be reduced or eliminated but at the cost of using more fuel. Hydropower can be produced, but only at the cost of inundated valleys and restriction of free-flowing streams. The production of pollution control equipment is itself a strain on the environment, albeit net effects are beneficial. Relationships among materials uses and environmental effects become more complex as the volume of mobile pollutants increases, thereby increasing the likelihood of compound and synergistic effects in any given place. Moreover, pollutants move from one medium to another, such as the transport of mercury by air from the stack of a power plant to a nearby lake, where it is deposited and converted to toxic compounds by microorganisms and concentrated in other organisms.

The movement of unwanted materials from one medium to another, concentration of poisons in sinks or by animals in the food-chain, and chemical-physical-biological changes in soils and surface waters are forms of environmental change that affect the "productivity" of nature as viewed by man. In some cases we measure "productivity" in

terms of a particular cultivable "crop," whether faunal or floral. In other cases we consider productivity in terms of the health of an ecosystem with its diversity of plants and animals, such as in a forest or lake, or the aesthetic pleasure that may be derived from such abundance. Environmental impacts that affect productivity and those that create aesthetic responses are likely to be intertwined, such as the effects of herbicides, whether evaluated in terms of the target area or misdirected use, or the effects of clearcutting and disposition of slash on a steep mountainside.

cf. chapter 5

cf. 2.3.5; 3.3.1; 4.1; 8.3

The scale of environmental impact of materials uses coupled with modern technology--whether a strip mine, a cleared forest, a complex of power plants, or an oil spill; or of disturbance in an environment that hitherto had been hostile to the sustained presence of man, namely polar region and desert; or by emission of large volumes of substances into global media; or of complexity and persistence, such as emissions of radioactive materials and materials that interact adversely rather than benignly--is vastly different from anything that has gone before. No part of the world remains unthreatened. All parts are threatened by large scale effects. The fact that we have inadequate knowledge of what happened in the past, is now happening, and will happen in the future argues for caution. Evidence of the possibility of global disaster may be inconclusive, but evidence of scarred landscapes, air pollution, water pollution, litter, depleted stocks of fish and wildlife, environmentally provoked morbidity and mortality, and fewer natural refuges to which man may repair are all directly attributable to the ways in which we extract and use minerals and forest products. The study committee believes that present concern for the environment is neither misplaced nor exaggerated.

1.3 Remedies and Institutions

The remedies for preventing or repairing environmental damage take one of several forms: (1) reduction of emissions; (2) dispersal of emissions; (3) improved protection of the landscape and ecosystem; (4) repair of the landscape and ecosystem that has been damaged by past neglect; (5) optimum siting of unavoidable damage; (6) concentration and safe disposal. Each of these remedies may be achieved in several ways. For example, improved protection of the landscape and ecosystem can be achieved by stipulating standards of exploration, extraction or harvest, zoning of activities, requirements or incentives for rehabilitation of sites, or direct governmental investment in rehabilitation.

Depending upon the form of the remedy and the antecedent form of environmental impairment, the remedy is attainable by one or more types of institutional control. For example, the threat of private suit for damages can inhibit environmentally damaging behavior. More commonly, the devices used are likely to be legal prohibitions of

undesired activity, compliance with affirmative standards as a condition of undertaking certain activities, taxes, subsidies, and direct governmental action. The choice of control technique is guided by the principles that apply to the choice of solutions of social problems generally; i.e., efficiency in use of resources to achieve established social ends, economy and simplicity of administration, and conformance with recognized principles of equity.

The remainder of this section is devoted to a discussion of selected remedies and institutional devices, and to special consideration of environmental problems posed by minerals, fuels, and forest resources.

cf. 2.2.9; 2.3.5; 6.1;6.4

1.3.1 Emissions Taxes

The harmful effects of point-source effluents, whether gaseous, liquid, or solid, and whether omitted to the atmosphere, bodies of water, or directly to the land, may be reduced by treatment at the "end of the pipe," by changes in processing at one or more points prior to final emission of the waste, by relocation to another point where the harmful effects may be less, by changes in product mix, or by reduction or cessation of operations. Common instances of unwanted emissions related to materials are sulfur dioxide, various particulates, heavy metals, municipal and industrial organic wastes, and heat. These emissions accompany a wide spectrum of milling, smelting, processing, and manufacturing activities and originate in the combustion of fossil fuels, use of nuclear fuel, and in the successive steps by which minerals, timber, and fibers are converted into finished products.

Because point-source emissions are identified with particular emitters and because there are various stages in the production process where reductions can be achieved, the study committee believes that the most efficient instrument of control is an effluent or emissions tax. In the case of a paper mill, for example, the imposition of a tax leaves to the discretion of the emitter at what stage of production the objectionable material is either modified, contained, or discharged and taxed. Moreover, the tax does not require that all emitters behave in the same fashion regardless of the marginal costs of abatement. Finally, the tax leaves to the emitter the choices of abatement, relocation, cessation of production, or payment of the tax. The search for new technology is uninhibited as to locus of impact, and the desire of consumers to shift from pollution-creating to pollution-avoiding goods and services can operate freely through the effect of the tax or costs of abatement on prices. The net effect, when all adjustments have been completed, is a system of prices that reflects the social costs of pollution and the balancing of these costs against the benefits of continuing to use the pollution-creating goods and services.

The use of an effluent tax implies that the tax rate is set to induce the amount of abatement needed to achieve a selected ambient quality. The procedure for finding the proper tax level involves trial and error, based upon available knowledge of the industry's cost structure, competitive conditions, and demand for its products. By moving the tax rate up or down the desired ambient level is achieved, granting the fact that there will be some lag between action taken to change the level of tax and response by emitters.

cf. 3.1.2; 3.5; 6.2.3

The abatement of polluting discharges per unit of product to a small fraction of present emissions is, to the best of the committee's knowledge, well within the economic capacity of the country and, if induced by an emissions tax, involves minimal disturbance of management decisions. The committee recommends that a national materials policy should prominently incorporate an obligation to reduce or eliminate undesirable emission, and that the primary instrument to accomplish this should be an emission tax, supplemented by other instruments as needed.

cf. 2.2.6; 2.2.9; 3.2.3; 3.5; 4.2.3; 5.2.1; 6.1; 6.6

1.3.2 Effluent Standards

Emissions that are determined to be dangerous to the health of humans or to organisms critical for the health and well-being of man should be controlled by flat prohibitions or a designated maximum for any emitter. The choice of instrument will depend upon the recognized toxicity of materials and the circumstances of emission. The emissions tax may not be suitable for elements that are serious threats to health because of the possible lag in time between imposition of the tax and final response.

An effluent standard might also be justified if conflict among political jurisdictions makes a tax politically infeasible. If an effluent tax is eschewed by the federal government, competition among the states to serve as pollution havens would be attenuated by a federal effluent standard. However, imposition of a minimum federal effluent tax also serves to eliminate undesirable competition among states.

In general, an effluent tax will do whatever an effluent standard will do except that aggregate social costs will be less with the tax than with the standard, or at worst, no higher.

cf. 2.3.1; 3.4 (all sections); 3.5; 5.2.1; 5.4 (all sections) 6.3; 7.4; 8.3

1.3.3 Dispersion of Wastes: Remedy and Problem

Dispersal of point-source emissions is a solution so long as the capacity of the environment to absorb the stress is not exceeded. Dispersal is achieved mainly by a land use policy and the use of such instruments as zoning, conditional leasing, geographic variations in emissions taxes, permits to emit, and public investment in waste treatment and control

facilities that offer locational advantages to those who are served. For materials that are discharged to the atmosphere, air zoning, although more difficult to administer, would be more effective. An awareness of the need for dispersal is most critical in areas subject to the compounding of effects from different kinds of emissions. Dispersal policies imply that decisions regarding land use are integrated with decisions regarding emission controls.

Unintentional dispersions of wastes pose their own problems, notably litter, fertilizers, pesticides, and mine drainage. Disturbances to the ecosystem by nondegradable (or slowly degradable) pesticides has led to their banishment in many countries. The problems of unwanted movement and dispersion comprise one of the most acutely dangerous aspects of materials use that we face. It is likely that the most feasible remedies will be redesign of the products so that they become harmless within a short time of application, or restriction or prohibition of use. Solution of the problems posed by migratory materials should receive high priority for attention within a materials policy.

cf. 3.4(all sections) 4.2.3; 4.3.2; 5.3(all sections) 5.7

1.3.4 Land and Water Conservation and Reclamation

Another major class of environmental impairments stemming from materials use is the disfigurement of the surface of the earth and associated damage to soils, biota, and to ground and surface water. These insults arise mainly from mining, mineral processing, and lumbering activities: tailings, slag piles, open pits, scarred hillsides, landslides, accelerated erosion and sedimentation, loss of soil nutrients, and contamination of surface and ground waters.

The committee believes that lumbering and mining operations can continue at a satisfactory volume provided essential practices to protect and repair the environment are followed as detailed in chapters 3, 4, and 5. The main instrument of control is the establishment and enforcement of environmental quality standards.

cf. 3.4.5-8 4.8; 5.1.2; 5.3; 5.7

The repair of land by proper disposition of spoil and revegetation of the surface is feasible in most parts of the country. Where repair is not possible, mining or lumbering should be prohibited. In the case of lumber, only a small percentage of commercial timber would be affected by such prohibition. In the case of minerals, a larger fraction is affected, since we still cannot adequately repair damage in arid and semi-arid, polar and subpolar environments. However, there has been enough progress in the development of suitable species of plants and methods to warrant a prohibition of the exploitation of nonreclaimable areas until these become reparable by new technology.

cf. 2.2.3; 2.2.11; 3.4.1-2; 3.4.7-8; 4.3.2; 4.3.6; 5.2.1; 8.3

As a condition of exploitation undertaken on public land, a performance bond and a preoperation design should be required by appropriate authority. The same requirement should be met for exploitation on private land whenever a critical boundary (cf. 5.2.1) is encountered--i.e., movement of adverse effect across a property or civil jurisdictional line or to another medium. The responsible government agency would approve the plan and monitor its performance. This procedure is recommended as an addition to the environmental impact statement now required as a precedent to action on public lands.

An environmental standard, is, in general, more important than specification of practices, since changes in technology will render particular practices obsolete. This conclusion should also hold for health and safety practices in mining and processing or manufacturing. Ambient standards as applied to water would prohibit, for example, the abandonment of mines and subsequent drainage of acid mine wastes.

As a part of contemporary materials policy, the study committee recommends that steps be taken to repair damages committed in the past. The cost of such repair will in most instances be borne by government, since the legal liability for past actions of private enterprises now in existence is likely to be negligible. No extension of exploitation rights by lease or other privilege should be granted without enforcement of all reclamation obligations that are still in force as well as those newly incurred.

cf. 2.3.2; 3.4 (all sections); 4.3.2; 4.8; 5.6 (all sections); 6.3; 7.2; 8.3

1.3.5 Land Use and Planning

Closely related to the planned dispersion of emissions and to land and water reclamation is the need for national, regional, state, and local land use planning. A materials policy that side-steps the establishment of national land use planning will not protect the environment under conditions of stress and will contribute to uncertainty in the development of resources. Land use planning will identify and protect wilderness and urban areas as well as designate appropriate sites for mining and harvesting timber. National planning should allow for regional and local upgrading either at the moment or over time as regionally or locally determined, subject to over-riding considerations of national welfare.

Planning of land use undoubtedly will begin and may remain limited to a small number of relatively coarse decisions. In addition to the determinations made for mining, timbering, agricultural and green belt uses of land, consideration will have to be given to urbanization, transportation and utility corridors and to ways in which land use affects air and water quality. Displacement of agriculture by growth of cities and transportation and utility corridors has already been noted as a problem with important environmental implications related to

materials use. Conversely, such land use planning must take account of the need to relieve congestion in megalopoles and foster the spread of communities in accordance with high environmental and conservation standards. Since many decisions are already being made at federal, state, and local levels under outmoded jurisdictional and institutional arrangements to fix or limit land use, the question is not whether we undertake such assessment but whether the scope of planning is sufficiently broad and innovative to give due consideration to the labyrinth of consequences and alternatives of land use planning and the "means" by which the planning process itself can be organized and maintained effectively. We now see that piecemeal solutions frequently do not solve the problems to which they are addressed but merely move the problem from place to place.

An especially vexing conflict of land use is that between dedication to wilderness and exposure to exploitation, since economic measures--i.e., ascertainable and measurable money costs and benefits--do not exist for all competing uses. We can develop partial money measures, such as the present market value of extractable timber over a designated period of harvest net of costs of extraction. We can also estimate the effect on costs of timber of marginal changes in supply. We cannot, however, by methods presently available, compute with comparable definitiveness the present value of a wilderness or of a change in the size of a wilderness. A governmental agency that has jurisdiction for land not only has the problem of estimating the intensity of demand for wilderness in the absence of a market but also the obligation of employing an interest rate that properly reflects the social rate of time preference. This rate may be different from prevailing market rates of discount used in business decisions. It is, of course, a fact that the total supply of virgin forest is incapable of expansion, yet an increasing number of people demand recreational services from the forest. The result is a prospective change in supply-demand relationship different from the prospective change in supply-demand relationships for timber per se, since timber can be grown more efficiently from much of the land presently harvested. Exploitation of forest land for minerals presents a foreseeable supply-demand relationship similar to that for recreation. The most important question in resolving such conflict of use is the relative availability of substitutes--either other materials or other forms of satisfaction or other sources of each and the respective intensities of demand, taking alternatives into account. The study committee believes that the best allocation of land between wilderness and exploitative uses lies in the direction of the suggestion made in section 2.3.2. According to that suggestion the total area subject to conflict would be divided in conformance with the perceived relative intensities of demand for virgin land as wilderness compared with the demand for virgin land as a source of materials, taking alternative sources of supply for both competing demands into account. This procedure would take the place of case-by-case decisions, in which each side in each case sees itself the victim of the cumulative effect of a sequence of all-or-none decisions.

Land use planning would give due consideration to fragility of the environment; cost of repair or regeneration; potential for irreversibility; and alternative uses, relative productivity levels, and environmental impacts of each use. For particular areas a sequence of uses might be readied, making the most of subsurface and surface resources before allowing investment in buildings and utilities that would be threatened by subsidence, flooding, or similar hazard prior to final reclamation.

cf. 2.2.2; 3.4.5-6

A major problem of land use planning related to materials use arises from the siting of power plants. The attraction of western coal in the context of growing power needs on the Pacific Coast has threatened large parts of the Southwest with serious air pollution and disturbance of land surfaces. If all social costs were borne by the polluter, the consumers of power in southern California would be expected either to pay for a reduction in the output of pollutants or to compensate the nation for the loss of a major asset--the bright light and blue skies of the Southwest. No energy policy should be proposed that does not take these environmental costs into account.

cf. 3.4.5-6

A more general problem is the failure at present to control the siting of industrial plants in order to avoid the compounding or synergistic effects of various emissions. Knowledge of these effects is still limited, but enough is known to call for caution in what is allowed. Ambient qualities must be stipulated in more sophisticated ways and the rigor of controls and enforcement must be correspondingly increased.

cf. 2.3.1-3; 3.4(all sections) 6.2; 7.4

Land use planning could employ various economic instruments to bring about a desirable dispersal of activity: variation in emission charges according to location, sale of emission permits to the highest bidder, conditional leasing of public lands, and zoning regulations. Land use planning would also protect public and private land from damages of multiple exploration for minerals. Leases for exploration could be issued by lottery or competitive bidding with a requirement that, in the case of public lands at least, results of the exploration be placed on file and made available to the public after a reasonable but relatively brief interval.

1.3.6 Design Standards

cf. 2.2.7; 2.2.8; 2.3.5; 3.3.3; 3.3.6; 6.2

Certain problems of materials use cannot be satisfactorily handled by emission taxes or effluent standards because of the nature of the source or the difficulty of measuring the environmental damage. Under these circumstances a short-term remedy or "technological fix" can be employed; e.g., by using design standard for pollution abatement equipment. An example of such a standard currently employed is the emission control equipment for automobiles. Specified practices for the repair of mined or cut-over areas may also be viewed as design standards.

The utilization of design standards can be and is being extended into other activities. A major source of materials use that contributes to environmental degradation are containers--bottles, cans, bags, and boxes--made of glass, steel, aluminum, plastic, wood, and paper; returnable and throwaway; combustible and noncombustible; degradable and nondegradable. The container industry is closely related to product identification and the monopoly of brandname, trade-mark, and advertising impact. Throughput environmental costs beginning with the raw material and ending with the final disposition of dispersed litter of the packaging-advertising-identification system are high, although no one has computed them for the economy as a whole.

If "the polluter pays" principle is followed and if the assessment of environmental damage is accurate, the consumer who uses convenient (but environmentally degrading) packaging would pay his own way. If these costs are at all consequential, however, the market system would provide the consumer with alternative forms of packaging that would not be encumbered by the costs of environmental damage. It would take experimentation to ascertain how application of the polluter pays principle would affect the environment in this context.

If there is strong demand for environmentally detrimental packaging, the imposition of a uniform or absolute design standard--e.g., reusable bottles and prohibition of throwaway cans--may be the only feasible form of control. Control over the adverse environmental effects of advertising--whether in the form of billboards, signs, use of energy, packaging, and use of paper and other materials that must be produced, delivered, and discarded--may be made difficult by the fact that advertising reduces elasticity of demand and augments power to withstand financial penalty. In the absence of responsiveness, design standards in the form of restrictions against environmentally degrading practices, coupled with design standards for packaging, will have to be used.

cf. 2.3.4; 3.3(all sections); 4.3.3; 4.8 5.4 (all sections); 5.7; 6.6; 7.4; 8.5

1.3.7 The Disposal of Unwanted Solid Wastes

A materials use policy must come to grips with the problem of solid wastes. These originate at various stages of the materials cycle and confront the environment with two problems: unwanted dispersal and unwanted concentration.

Recycling, development of uses for presently unwanted materials, and replacement of materials in or on the land constitute the remedies. Because of tax advantages and perhaps advantages in freight rates enjoyed by original materials the picture is not as clear as it might be. Moreover, even if total costs of recycled materials are higher than total costs of original materials, ignoring environmental effects, inputs that adversely affect the environment, such as energy, may be less. The desirability of eliminating litter and reducing other damages

to the environment implies that costs of using recycled materials should be computed after adjusting for the net environmental benefits yielded by using recycled materials, the reduced costs of handling solid wastes, differences in tax liability, and differences, if any, in freight rates. Whether recycling is economically feasible after such recomputation is not yet known. A materials policy should include a search for the facts and adoption of environmental protective practices supported by the facts.

A possible solution to the problem of solid waste disposal is use of a materials tax and tax rebate mechanism. Such tax would be imposed on materials at the point of extraction, just as a severance tax is used in many states in lieu of a property tax. The tax would be "rebated" to anyone who "deposits" in an environmentally acceptable depository an article containing the materials. Costs of administering such a system should be estimated and experimental models developed. Since many durable materials migrate extensively, the taxing and funding of the rebates should be federal. The system would be extended to imported materials--whether in raw or finished form--at the same rates as for domestic.

cf. 3.3.4; 3.4.1-2; 3.4.7-8; 4.3.3; 4.7.2; 4.8

Mine wastes are usually disposable in underground or surficial voids. The surface of mined areas when regenerated by vegetation or when dedicated to other socially beneficial uses presumably no longer constitutes the source of environmental problems. At present, the landscape is disturbed without complete extraction of valuable minerals. Some time in the future, if mineral prices have risen relative to the costs of labor and energy, residuals probably will be reworked, to the continued detriment of the environment. To handle this problem solely by imposition of the costs of environmental damage on the mine operator may not be a completely satisfactory solution. There will be a prospective future price of the material that would stimulate recovery of ores from tailings of low concentration at the public rate of discount but not at the going rate of interest in the business sector. Imposition of a tax may lead to a waste of energy caused by replacement of tailings before they have been reworked, only to have them reexposed when the price of the ore rises in the future.

The process of extraction and regeneration could be accelerated by a two-level price system whereby the federal government would purchase minerals that would be processed from tailings and pay a premium price to support the added costs. If the operator of the "tailing mine" were wholly independent of the operator of the regular mine, the possibility of collusion to take improper advantage of the premium price would be reduced. The premium would represent the public's valuation of a once-and-for-all environmental disruption and repair, in comparison with present conditions where tailings might be reworked once or twice before final disposition, based upon the social rate of discount.

cf. chapter 4

1.3.8 Fuels: An Especially Complex Problem and Its Remedies

A materials policy directed toward fuels must take into account the environmental stresses created by: (1) extraction; (2) exposure to accident and disease in mines; (3) emissions of chemicals and particulates to air and water; (4) emissions of waste heat; (5) oil spills and leaks, on land and at sea; (6) visual effects of power stations, power lines, tailings, and spoil; (7) disturbances created by roads, exploration activity, pipelines, and drilling; and, (8) the possibility of radioactive exposure.

In view of the expansion in the use of fuels that is expected unless major social and technical measures are taken to change current trends, the committee believes that an energy policy should be developed for the United States that will be based upon due consideration of environmental impacts, with recognition that costs of fuels and electric energy will be correspondingly increased.

Where technology to maintain a satisfactory quality of the environment has not been developed, the extraction, transport, and use of fuels should be prohibited. This policy further implies that those who use the fuel may determine for themselves the degree of environmental degradation they will suffer in order to enjoy use of fuels, but that degradation may not be imposed on others without consent and compensation on the basis of full awareness of what is entailed.

The growing rates of extraction and use, compared to inferred potential resources of petroleum and natural gas, presents a special problem for a national materials policy. Exhaustion of the world supply of these materials could occur within so short a period of time that ready substitutes would not be available for critical energy and petrochemical industry use. Consequently, a government policy directed toward elimination of large scale, highly inefficient use of petroleum and natural gas, for which substitute energy sources are currently available, is of prime importance. For example, replacement of oil and gas by coal suitably prepared for clean burning should occur as rapidly as possible.

For similar reasons a reduction in the amount of automobile fuel consumed through smaller auto size and more efficient energy delivery must be pursued under government leadership. These measures are needed not only to conserve scarce materials but also to reduce emissions into the atmosphere and environmental damage associated with the discovery and extraction of increasingly elusive supplies of oil and gas. The alternative to economizing steps such as these is likely to be much more stringent control of energy use. Moreover, it is not yet clear that stringent controls can be avoided even if all moderate steps are adopted when account is taken of the atmosphere's capacity to absorb waste heat without damage to life processes.

cf. chapter 5

1.3.9 Renewable Resources: The Critical Need for Remedies Designed to Maintain Productivity

The effects of environmental stress are especially dramatic within a heavily cut forest during and immediately after the harvest of timber. There are enough uncertainties regarding forestry techniques to make hazardous any generalization regarding particular practices. A few generalizations seem safe, however: (1) the value of timber now being cut from some areas is less than the costs of extraction plus the costs of regeneration and maintenance of productivity; (2) some harvesting practices, when improperly used, threaten to reduce the productivity of the land because of loss of soil and soil nutrients; (3) a relatively large proportion of the nation's total forested area, especially areas in the form of small holdings, is administered by relatively ineffective methods when measured against the present state of knowledge; (4) we are deficient in the knowledge of many aspects of forest management and the behavior of the forest biome; (5) we know even less about the management of tropical zone forests than we know about temperate zone forests.

In addition to the obvious need for intensified research directed toward protection of the ecosystem and the maintenance of long run productivity, a number of devices and policies designed to reduce environmental degradation of forest areas can be listed: (1) fragile forest areas should be withdrawn from the timber supply base; (2) adherence to approved environmental standards should be a condition of the right to remove timber, whether on public or private land; (3) federal government support of forest culture where needed to: (a) recognize the social benefits of forests for purposes other than timber production; and, (b) offset imperfect applications of market processes and state and local tax policies that are not suitably designed for an activity of long nurture and correspondingly higher risk.

1.4 Summary of Detailed Recommendations: Domestic Considerations

A national materials policy should start with the ethical principle that a sensitive community lives in harmony with its natural surroundings, with the realization that the environment is a resource of limited size, and with recognition of the imminent possibility, if not immediate reality, of abusing our air, water, and land beyond the limits of tolerance. Appreciation of the importance of environmental considerations as an integral part of national policies and laws aiming at the conservation and development of our national resources should be made a permanent and binding requirement by codifying "man's right to a healthful environment" in appropriate legislation and eventually the Constitution. Educational and information programs that command attention and raise public awareness should be expanded and raised to a level commensurate with the importance of the subject.

1. A national materials policy should be based upon the principle that calculations of benefits and costs associated with the extraction, transport, processing, use, and disposal of materials, should take full account of the value of common property resources and of any change in the value of common properties resulting from the impact of materials on the environment; and should support the principle that those responsible for impairment of the environment should bear the costs of damage or repair. These principles should become a commonplace element of property rights, legislation, and administrative practice at all levels of government. The difficulty of measuring benefits and costs should not delay adoption of these principles but suggests the need for continuous observation and experimentation.

2. In establishing health and safety standards, the traditional concept of a threshold must be modified to reflect that it does not represent a safe level of exposure for unusually sensitive members of the population (cf. 1.2.1). Health and safety laws and practices should also recognize that total body burden rather than exposure in selected environments should serve as the basis for establishment of safe standards. Standards should be constantly reviewed in light of new information regarding hazards and techniques of control. New mines, processing plants, and factories should be obliged to adopt the best available technology, with older installations upgraded or abandoned at a reasonably rapid rate. Sufficient baseline surveys and studies of specific populations over time should be undertaken and monitoring networks should be developed and utilized to reveal threats to the health of man and other parts of the ecosystem not only from the gross changes of which we are already aware but also from the slow and subtle changes that are suspected.

3. Federal legislation should be introduced that calls for and provides administrative coordination of land use planning, atmospheric zoning, and the zoning of water resources at federal, state, and local levels, and that coordinates with the planning of transportation systems, public utility facilities, and utility corridors and with the administration of environmental control practices. Land uses would be determined on the basis of productivity, reclaimability, fragility, and relative intensities of demand for different services of the natural environment. Of special concern are the delineation of urban areas, agricultural lands, mineral reservations, forests open

to commercial exploitation, forests devoted to uses other than timbering, multiple purpose areas, wilderness and parks, and especially vulnerable airsheds, drainage basins, land forms, soils, and ecosystems or subsystems. Planning should take into account the prospect of population growth, the fixity of space, and the probable demands and capabilities of future generations.

4. A compatible national energy policy should be formulated in conjunction with a national materials policy. An energy policy should not be limited to evaluation and use of available supplies at home and abroad but should also consider controls on demand for energy consistent with the needs of a high quality natural environment. Federal legislation should be introduced that calls for coordination in development of energy and environmental policies and administrative actions.

5. Exploration, extraction, and harvesting should be restricted to those occurrences and areas where damage to the surface of the earth and productivity of the ecosystem can be repaired or averted. As the technology of protection or reclamation advances, additional resources can be made available for development. In relatively few instances where marginal social benefits are sufficiently large and marginal costs of repair are sufficiently high, some environmental damage may be tolerated. Legislation should be introduced directing agencies to establish environmental standards where these do not now exist, to require performance bonds and plans for preservation of the environment prior to startup of activity that threatens environmental quality, and to monitor performance. State and local governments should be permitted to impose environmental requirements beyond those established by the federal government. Insofar as the law can provide, protective requirements should be the same for actions on private as well as public lands. Materials processing and other industrial activities that threaten the environment should be subject to the same restrictions as those applicable to exploration, extraction, and harvest, to the extent that can be required by law.

6. Economic policies should be coordinated with policies designed to enhance the quality of the environment. Economic controls should be used to discourage production of goods and services that reduce environmental quality and encourage production of those that impose minimum environmental stress. Efforts should be made to

stimulate longevity of commodity life, reduce stylistic obsolescence, and encourage use of materials and designs that facilitate recycling. Price regulations, charges for the use of public lands, tax provisions, and government procurement, spending, and investment policies that now stimulate use of environmentally damaging materials at the expense of others less damaging should be abandoned except in the face of obvious national need.

7. A national materials policy should use those administrative devices that achieve the objective of protecting and enhancing the environment at least cost to society. For those instances in which an efficient emissions standard is feasible, an emissions tax is usually able to achieve the same environmental effect at lower aggregate cost and with less interference with the responsibilities of management. For other forms of environmental disturbances the appropriate device will be a prohibition, design or performance standard, sale or grant of permits, or a materials tax. In general, subsidies should be avoided because they lead to poor allocation of resources. However, in the face of unequal distribution of income, external benefits to be gained or costs averted, and political opposition to other devices, subsidies may be the most feasible way of achieving a better environment. Direct government investment is justified where economies of scale and external costs or benefits are significant, where a common property resource is involved, or where appropriate behavior by the private sector cannot be elicited by enforcement of environmental standards.

The attached Chart 1.1 lists twenty-three federal acts now in effect that relate to environmental concerns. An "x" indicates an intersection between an act and a recommendation of the committee, indicating that the recommendations are made in a political and legislative context already prepared to cope with environmental problems. Existing legislation, however, is neither extensive enough in scope nor powerful enough in sanctions to induce the social response that the committee finds necessary. A national materials policy should call for a review of existing legislation in order to ascertain the degree to which present laws can be made more effective and where wholly new legislation is needed.

APPLICABILITY OF SUMMARY RECOMMENDATIONS TO MAJOR ENVIRONMENT-MATERIALS LEGISLATION

Legislation	Recommendations 1. Benefit/cost of the commons	2. Health; Best available technology	3. Land Use Planning: Coordination with Environmental Planning	4. Energy Policy: Supplies, Demands, and Environment	5. Restrictions on Environmentally Damaging Activity: Extraction & Processing	6. Coordination of Environmental and Economic Policies	7. Administrative Devices
National Environmental Policy Act of 1969 (42 USC 4321)	x	x	x	x	x	x	
Federal Water Pollution Control Act (33 USC 1151)	x	x			x		x
Marine Protection Research & Sanctuaries Act of 1972 (P.L.92-532, 86 STAT. 1052)	x						x
Clean Air Act (42 USC 1857)	x	x			x		x
Solid Waste Disposal Act (42 USC 3251)	x				x	x	
Mineral Leasing Act of 1920 (30 USC 185)			x				x
Mining & Minerals Policy Act of 1970 (30 USC 21a)		x	x	x	x	x	x
Occupational Safety & Health Act of 1970 (29 USC 651)		x					x
Coal Mine Health & Safety Act of 1969 (30 USC 801)	x	x			x		x
Multiple-Use Sustained-Yield Act of 1960 (16 USC 528)	x		x	x	x		x
Wilderness Act of 1964 (16 USC 1131)	x			x	x		x
National Park Service Act of 1916 (16 USC 1)	x			x	x		x
Food, Drug & Cosmetic Act (21 USC 301)		x					x
Federal Insecticide, Fungicide & Rodenticide Act (7 USC 135)		x					x
Federal Aid Highway Act (23 USC 138)			x				x
Federal Power Act (16 USC 800)	x		x				x
Land and Water Conservation Fund Act (16 USC 460)				x			x
Oil pollution Act of 1961 (33 USC 1001)					x		x
Endangered Species Conservation Act of 1969 (16 USC 668)	x						x
Taylor Grazing Act (43 USC 315)				x			x
Fish & Wildlife Coordination Act (16 USC 661)	x		x	x			x
Wild and Scenic Rivers Act (16 USC 1271)	x			x			
Outer Continental Shelf Land Act (43 USC 1331)			x				x

Chart 1.1

1.5 International and Global Environmental Considerations

cf. 5.5.1; 5.5.4; 6.8; 7.3; 8.10.2

The United Nations Conference on the Human Environment, held at Stockholm in June 1972, epitomized the evolution of the environment from a local to a national and eventually to an international concern. A series of determinants converged to produce this result.

Internationalization reflects growing awareness of the detrimantal effects of economic and technological development upon the quality of the environment, the adequacy of natural resources, and the threatened extinction of species. Inadequate anticipation of world-wide, long run supply and demand relationships, especially in light of growing demands of developing countries, is held responsible for jeopardizing adequate supply and for premature depletion of basic materials needed by more slowly developing nations.

cf. chapter 7

Governments have realized that international action to deal with environmental problems at the source and at critical points of manifestation is needed. Such action has been initiated through established international channels and organizations with appropriate modifications of original mandate and machinery (e.g., Organization for Economic Cooperation and Development, North Atlantic Treaty Organization, Economic Commission for Europe), through members of the scientific community (e.g., Scientific Committee on Problems of the Environment), and through the creation of new institutions and mechanisms (e.g., the Stockholm Conference and the new environmental bodies generated there). The result has been a host of new conventions, agreements, resolutions, and recommendations designed to enlist the cooperation of governments and nongovernmental organizations in support of specific programs. In contrast to national policy, the international initiatives are neither legally binding nor enforceable but rest largely on the power of moral suasion, on the determination of governments to honor their commitments, and on the ability of governments to marshall domestic support for their commitments. The international innovations have created, nevertheless, a new political climate, a new set of political ground rules, and new principles of international conduct which governments will find increasingly difficult to ignore or defy.

Third, the establishment of national environmental controls is bound to have a variety of transnational effects of a political, economic, and technological nature. The effects can be positive or negative. National controls may move other nations to agree to the adoption of common standards, policies, and practices or may provoke counteraction designed to neutralize and even combat the effects of controls outside the country of origin, especially if controls are suspected of passing on the problem to other countries (through the establishment of pollution havens) or placing the latter in a position of competitive disadvantage. The uncertainty of reaction--whether supportive or competitive--suggests the need for international instrumentalities to deal with contingencies promptly and effectively.

Formal international environmental actions antedate Stockholm by nearly two decades.* Moreover, the growing injection of environmental considerations into programs originally designed for wholly different purposes demonstrates that the United Nations will have to share credit and responsibility for environmental initiatives with a host of other sponsors.

cf. chapter 7

The Stockholm Conference presented the world with the most comprehensive action program and the broadest spectrum of international sponsorship to date. As one of the most active participants and the original sponsor of the resolution which established the new executive structure, the United States has assumed special responsibility for continuing support as well as an obligation to bring about, as far as possible, a harmonization of national policies with the principles enunciated at Stockholm. The most important principles adopted in Stockholm and relevant to the requirements of a national materials policy are those concerned with the protection and rational management of the earth's natural resources and environment, control of the discharge of toxic substances and heat, protection of the seas, and the integration of ecological considerations in development planning. Other relevant principles include application of science and technology to the identification and control of environmental risks; education, research, and development with respect to environmental problems and their management; and the development of international law to compensate for environmental damage caused by states in areas outside their jurisdiction. The 109 recommendations adopted either unanimously or by majority decisions were organized in five principal categories: planning and management of human settlements for environmental quality; environmental aspects of natural resources management; identification and control of broad international significance; educational, informational, social and cultural aspects of environmental issues; and development and environment. In their aggregate they form the so-called "Action Plan". They are addressed for purposes of implementation to governments, to United Nations bodies and agencies, and to nongovernmental organizations. They are binding only upon United Nations bodies. However, a special Resolution on Institutional and Financial Arrangements provides new machinery for joint action and coordination by governments, United Nations agencies and nongovernmental organizations.

---

* In 1940 the United States acceded to the Convention on Nature Protection and Wildlife Preservation; in 1944 it concluded the International Whaling Convention, and in 1954, the International Convention for the Prevention of Pollution of the Sea by Oil.

In its relations with other countries, whether bilaterally, multilaterally, or through participation in international agencies, the committee expects the United States to follow practices that preserve its own interests as well as those of the world at large. This coincidence of interests is most likely to be attained if actions of the United States in pursuit of a national materials policy conform to generally accepted principles of international relations, political and economic, whereby the United States:

cf. 7.3	1.	supports the principle that man has a fundamental right to adequate conditions of life in an environment of quality;
cf. 7.1	2.	recognizes its responsibility to help safeguard the natural resources, including air, water, and land; and to help preserve the nonrenewable resources of the earth.
cf. 7.4	3.	joins with other nations in efforts to prevent the pollution of the seas;
cf. 6.4; 8.9	4.	supports the right of each nation to decide for itself, insofar as the decision has no adverse external environmental effects, the quality of its own environment and the steps taken in conformance with that decision;
cf. 6.4; 7.3	5.	makes available full information to any country regarding the quality of and potential threats to the environment as related to any practice regarding materials extraction, processing, transportation, use, or ultimate disposition;
cf. 6.1; 6.2.3; 6.4; 7.1; 7.2	6.	supports general adoption of the "polluter-pays" principle as part of a materials policy, but accepts and takes no retaliatory action against the products of a nation that follows other practices in financing its own environmental control programs;
cf. 6.4; 7.1; 7.3; 8.10.2	7.	supports the principle that in accordance with the Charter of the United Nations and the principles of international law, nations have the responsibility: (1) to ensure that activities within their jurisdiction or control do not cause damage to the environment of other nations or areas beyond the limits of national jurisdiction; and (2) to cooperate in the development of international law regarding liability and compensation for the victims of pollution and other environmental damage caused by such activities;
cf. 6.1; 7.2 8.9-10	8.	adjusts to business decline or persistent balance of payments disequilibrium as a consequence of environmental controls

and increased competition from abroad by use of general fiscal and monetary devices, labor retraining and relocating programs, and other practices that do not offset comparative advantage as revealed after accounting for the environmental standards established by each country and the ease with which they can be achieved. Import restrictions should be used only in areas where required to protect the domestic environment (of the United States) and should be applied on a nondiscrimatory basis relative to materials and products of domestic origin;

cf. 6.4; 7.3 9. follows procedures which ensure that environmental impacts of foreign aid projects are brought to the attention of recipient countries and that plans and analyses reflecting consideration of such impacts are worked out in close cooperation with those countries, thus avoiding any implication of coercive pressure on host countries or the imposition of United States standards, priorities or procedures on the decisions of foreign governments having domestic importance only;

cf. 5.5.3; 7.3 10. participates in the development of an equitable arrangement for the payment of compensation to habitat countries when global decisions to protect certain species impose a consequential economic burden on the country;

cf. 5.5.3; 7.3 11. joins with other nations in mutual agreement to avoid environmental hazards and to protect endangered species, recognizing the restrictions that such agreement may impose on the exercise of the will of sovereign powers;

cf. 7.2 12. vests the United States-Canada International Joint Commission and the Boundary and Water Commission, United States and Mexico, with comprehensive authority for environmental matters concerning boundary waters and airsheds;

cf. 7.3 13. encourages the preparation of environmental impact assessments by international financing agencies;

cf. 6.6; 7.4 14. facilitates improved environmental protection of the oceans by supporting negotiations for enforceable prohibitions against threatening practices, and by supporting steps to define the boundaries of territorial and adjacent waters more precisely;

cf. 7.5 15. joins with Canada and other appropriate and interest nations in taking whatever steps are necessary on binational and multinational bases to protect the environment of the Arctic Basin.

cf. chapter 8

Competition in world markets for materials that contribute minimum environmental damage while meeting industrial needs will become more intense in decades to come. Japan and the United States, and both vis-a-vis western Europe, are likely to be the main competitors as each seeks to accommodate to its respective aspirations. In anticipation of an ultimate equilibrium among competing forces, the study committee recommends several initial steps to be taken by the United States in its relationship with Japan with extension to other countries as appropriate:

1. that current consultative procedures between both governments be continued and extended at all levels--executive, foreign policy, economic policy, materials policy, environmental policy, and on specific technical problems;

2. that both countries give close consideration to the implications of growing competition between them for supplies of certain desirable raw materials and that both work toward an expanding, unhampered trade system;

3. that both countries seek to harmonize their relations with raw materials-producing developing countries, particularly in matters of development and technical assistance, thus avoiding the tensions and risks of power rivalry;

4. that both countries use their world influence to support the international organization and programs proposed at the United Nations Conference on the Human Environment at Stockholm.

cf. 6.5; 7.3; 8.7; 8.9-8.10

United States multinational corporations are likely to maintain a major role in the transmission of technology and the convergence of environmental standards of developing and developed countries. The committee recognizes that multinational corporations are subject to local environmental policies and competition with corporations of other countries. In spite of these constraints, because of size and importance in world markets, multinational corporate enterprise is able to exercise freedom in the degree of concern it displays toward the environment and the way it exerts its own influence regarding the establishment of environmental policies in countries of which it is a resident. Private enterprise, in general, has freedom in deciding which practices are proprietary and which, as they relate to technology applicable to the environment, can be put into the public domain. Multinational corporations should assume responsibility for disclosing fully the prospective environmental impacts of any activity they will undertake. If multinational corporations attend to the environment to the maximum rather than minimum limit that circumstances in each host country allow, their role as active participants in the adoption of environmentally beneficial practices will be maximized.

The way in which multinational corporations can be induced to adopt practices that reflect a high level of concern for environmental quality when the host country doesnot impose environmental controls and when no public funding is entailed should be investigated as part of a national materials policy.

Except for reference to United States-Japanese competition in world markets, the committee has not addressed itself to the question of allocating world supplies among specific nations. Apart from the general supply-demand relationships that impending economic development throughout the world implies, there is the special question of environmental considerations. What machinery should be used to allocate resources that have special environmental significance? Should special machinery be used? If so, by what rules would it operate? What materials would be subject to such machinery? While these questions may not be immediately central to a national materials policy they are of great consequence and should be pursued by appropriate national and international officials.

1.6 Research and Monitoring: Unfinished Business

The pace with which action to protect the environment has grown, from an almost standing start hardly more than a decade ago, has not yet matched the speed of environmental degradation in spite of particular instances of improvement. In addition to the need for a wide range of policies, administrative actions, and remedial steps as described in the previous sections of this chapter and elaborated upon in the team reports that follow, there is an urgent need for basic research, research directed toward the solution of specific problems, the acquisition of basic data, and a monitoring network. An essential component of a materials policy is the flow of information by which management of the environment can be accomplished. Acquisition of this information implies orderly and close collaboration with international and other national information systems.

cf. 2.2; 2.4.1; 3.2.4; 5.5.4; 6.8; 7.2; 8.10

The various environmental impact statements of which the committee is aware do not always convey information that is needed on effects, remedies, or the ways by which remedial action is managed. In addition to these gaps in knowledge it is possible that much is happening of an ominous nature about which scientists are unaware or at best suspicious.

cf. 4.3.5, 5.2.1 7.3

Given the state of uncertainty regarding the boundaries of knowledge, the only safe course of action is an investigative program of sufficient magnitude and intensity. The committee believes that an investigative program that will provide longitudinal data (studies of specific populations over time) on human health should be undertaken over a spectrum of localities ranging from those in which emissions

cf. 3.2.3, 3.2.4

are known to be high to those suspected of being untouched. Without such studies it will not be possible to establish the toxic effects of low level but prolonged exposure. Federal financial support of environmentally related health studies should take cognizance of changes in congestion, vehicular traffic, meteorological conditions, and living styles that might be suspected of having a relationship with health. These environmental epidemiologic studies should incorporate sufficiently refined data on environmental characteristics to reveal changes over time; changes in total body burden; synergistic and antagonistic effects; and the classification of parameters according to relevance to health. Studies should include data on toxic materials carried by air, food, and water and how these media affect absorption by humans. Measurements should include environmental qualities of industrial plants, industrial areas outside the plants, and the community in general.

The need to control industrial emissions imposes a research and development obligation throughout all industrial stages, not only at the terminal stage of emissions. Once such efforts become a sustained obligation at all levels of industry, the costs of abatement are likely to fall below current estimates. The record to data provides strong support for such optimism. Two of the most serious problems, because of health hazards that are entailed, that have received inadequate attention are the control of fine particulate and the understanding of synergistic effects among pollutants.

cf. 2.2.2; 3.3.6; 3.5; 4.2.1; 6.8; 8.5

As noted elsewhere, the long-range effects on climate of chemical and particulate emissions and of heat discharges are not known, although there is sufficient basis of concern to warrant a global effort at resolution. Closely related to questions of climate are the phenomena of long distance transport of various emissions, their concentration by physical and biological processes, and their effects on rainfall and the oceans.

The contribution of improper land use to wind and water erosion and transport of sediment to the sea converts a domestic into an international environmental control problem. A materials policy should address itself to the nature of the research efforts that should be undertaken in different parts of the world, taking cognizance of climate, soils, forestry-agricultural rotations, and social-economic institutions. The way in which trees are grown and harvested is likely to become a matter of global concern because of the impact of forestry practices on the biological productivity of large areas of the world. Productivity in this context covers not only the production of wood but also the entire forest-related ecosystem, the production of stream runoff, beneficial or adverse climatic effects, and control over the mass movement of land. A major program of basic research and refined monitoring of environmental factors on a global scale is urgent.

cf. 5.3; 6.4; 7.4

cf. chapter 5

Research is equally urgent on problems of migratory materials originating in agriculture and the loss of prime agricultural land, with the consequent increase in on-the-farm use of chemicals and fuels and their adverse environmental effects.

cf. 2.4; 2.4.1; 3.1.2; 5.1.3; 5.7; 6.9; 8.2; 8.9

A materials policy should support investigation into, simulation of, and experiments with large scale changes in the way of life and manner of materials use. Current living patterns in the western world are a direct outcome of the industrial revolution and its preoccupation with the mass production of fuels and materials. The forms of urban disturbance that we currently experience are the product of antecedent forces that have been at work long enough to provide a sense of historical necessity yet short enough to indicate that they might be only a passing phase. If present trends of materials use are extrapolated into the future, even if there were to be a drastic reduction in the rate of population growth, the results of the doubling of production every fifteen or twenty years on a global scale will clearly be disastrous. The question is, what can be done? A materials policy should support a number of investigations and models that test radically new solutions: urban design and transportation networks; energy demand and production and distribution systems; packaging-marketing-advertising systems; nonmaterials-oriented recreational activities; design changes that increase durability, eliminate planned obsolescence, and rely upon materials that impose minimum stress on the environment. The committee recommends study of national economic models that are disaggregated into regions and that incorporate alternative environmental standards and population growth rates.

cf. chapter 4

Among the new systems that urgently call for study, that of energy, is paramount. Limited evidence suggests that basic research and experimentation with solar and geothermal energy should be substantially increased. Although utilization of these forms of energy will pose environmental problems, their use is likely to lead to a reduction rather than increase in environmental stress. Probably the most impressive long run prospect is held out by controlled thermonuclear *cf. 4.7.2 reaction*, as an abundant source of energy and as one that could contribute minimal damage to the environment. The prospective interval of time until fusion becomes a feasible source of energy, however, *cf. 4.3 (all sections) suggests that coal* will become the dominant fuel as oil and gas supplies are depleted. Research on reducing the environmental damages created by use of coal is urgently needed, with gasification at the mine probably being the most promising.

The need for a major increase in research support can scarcely be overstated. If words such as "crisis" or "catastrophe" seem to be unscientific exaggerations of the nation's environmental state of health, it is only because of the faith that we have in technology and social measures to reverse trends that are now ominously under way.

Because the environment is a common property resource, and because the private sector will undertake only those activities that relate directly to its private accounting of costs and benefits, major responsibility for support of environmental research must rest with the federal government. A materials policy should provide adequate support for the study of institutional arrangements that are needed to facilitate environmentally desirable adjustments as well as for technological research. It should also recognize that the nation's welfare is inextricably bound up with the state of the global environment, and that improvements in the methods of producing and using materials in a distant place may enhance the economy and quality of life at home.

The study committee urges Congress and administrative agencies to increase substantially their support of research in both pure and applied topics and to support investigations and pilot projects in large-scale system changes. In light of research capability now available, the level of funding for environmentally focused research and development could probably be doubled without unduly straining the research capacity of the nation.

1.7 A New Emphasis

Evaluation of considerations relating to a materials policy in light of what has happened since the report to President Truman of the President's Materials Policy Commission in 1952, William S. Paley, Chairman, indicates where the new emphasis should be.*

A policy for the seventies, and probably thereafter as well, will reflect awareness of prospective changes in environmental quality associated with alternative paths of economic growth and materials uses. The study committee supports all steps that can be taken within the federal government, beginning with Constitutional protection of individual rights and extending to all action that can be taken by the executive office of the President and the Congress, to bring environmental factors into prominent and sustained consideration as part of the evaluation of national priorities, and to provide assurance that decisions within the federal establishment give due regard to the fact that an environment of high quality is a major component of national well-being.

---

* Paley, W. S., July 9, 1972. "U. S. Agency Needed: Constant Review of Policy is Vital," The New York Times