ENVIRONMENT CANADA - PLANNING & FINANCE SERVICE - DISCUSSION PAPER #

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THE CONCEPTS OF ENVIRONMENTAL COSTS

Planning and Finance Service

Environment Canada

Discussion Paper Series

NO. 1

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FOREWARD

The concepts in this paper were developed over the past three years from the Policy, Planning and Evaluation Directorate's efforts in mathematical policy modelling. The time has come for the Department of Environment to adopt a set of concepts on which to base our planning efforts. This discussion paper is a step in this direction. We plan to follow it up shortly with direct consultation with the other planning groups of the Department.

Any comments that you may wish to make concerning the concepts in this paper should be directed to Peter Maniate of the Planning and Evaluation Branch or Donald Carter of the Policy, Priorities and Strategies Branch.

D.C.S. Edwards
Director-General
Policy, Planning and Evaluation
Directorate

Table of Contents

		Page
1.	Introduction	1
2.	The Authors' Conceptualization	1
3.	Expenditures and Catch-up Costs	6
4.	Annualized Costs	7
5.	The Trade-offs (Benefits and Costs)	8
6.	Direct versus Indirect Costs (debt charges)	9
7.	Transaction Costs	12
8.	General Problems	13
Appendix I - Dales' Conceptualization		15
Appendix II - E.P.A.'s Conceptualization		18
Figure 1 - Types of Environmental Costs		2
Figure 2 - Different Methods of Examining P.C.C. & D.A.C.		3
Figure 3 - Types of Waste Disposal Costs		17
Figure 4 - Types of Pollution Abatement Costs		19
Illustration 1		10
Notes		20

1. Introduction

The purpose of this paper is to suggest a common definitional and conceptual base with which to approach the subject of environmental costs. The paper presents a definition of terms and illustrates the concepts behind these terms. *Environmental costs* are the total costs incurred by society in the managing of its wastes. In practice, cost estimates are thought of in terms of air, water and solid waste, but conceptually other areas such as noise pollution and aesthetic degradation are included.

Benefit-cost analysis is currently the major technique for decision-making in government. However, to properly apply it in the environmental field requires a knowledge of all the costs involved. The term *costs* means the net cost of all the sacrifices involved, not merely the readily quantifiable money transactions. Ideally, these sacrifices should be expressed in some sort of common comparative unit and, so far, the only common denominator available is an expression of value in dollar equivalents.*

2. The Authors' Conceptualization

Our classification of environmental costs has developed from our efforts in mathematical policy modelling. The classification incorporates the concepts of both Dales[1] (see Appendix I) and EPA[2, 3] (see Appendix II). The diagrammatic summary of the conceptualization is presented in Figures 1 and 2.

Environmental costs can be of two general types: pollution control costs and pollution costs (see Figure 1).

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*Also known as a *shadow price*

Figure 2
DIFFERENT METHODS OF EXAMINING
P.C.C. AND D.A.C.

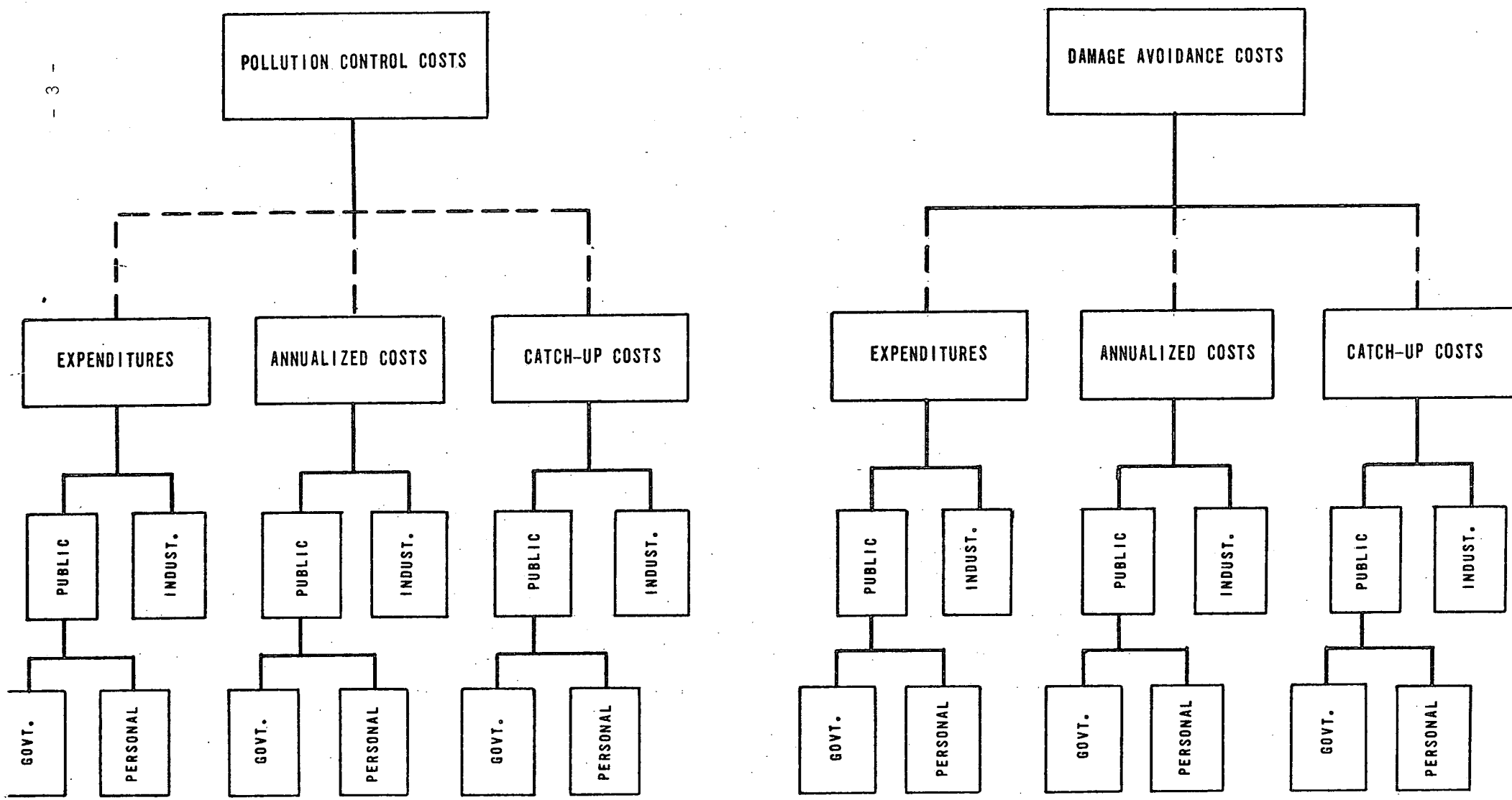
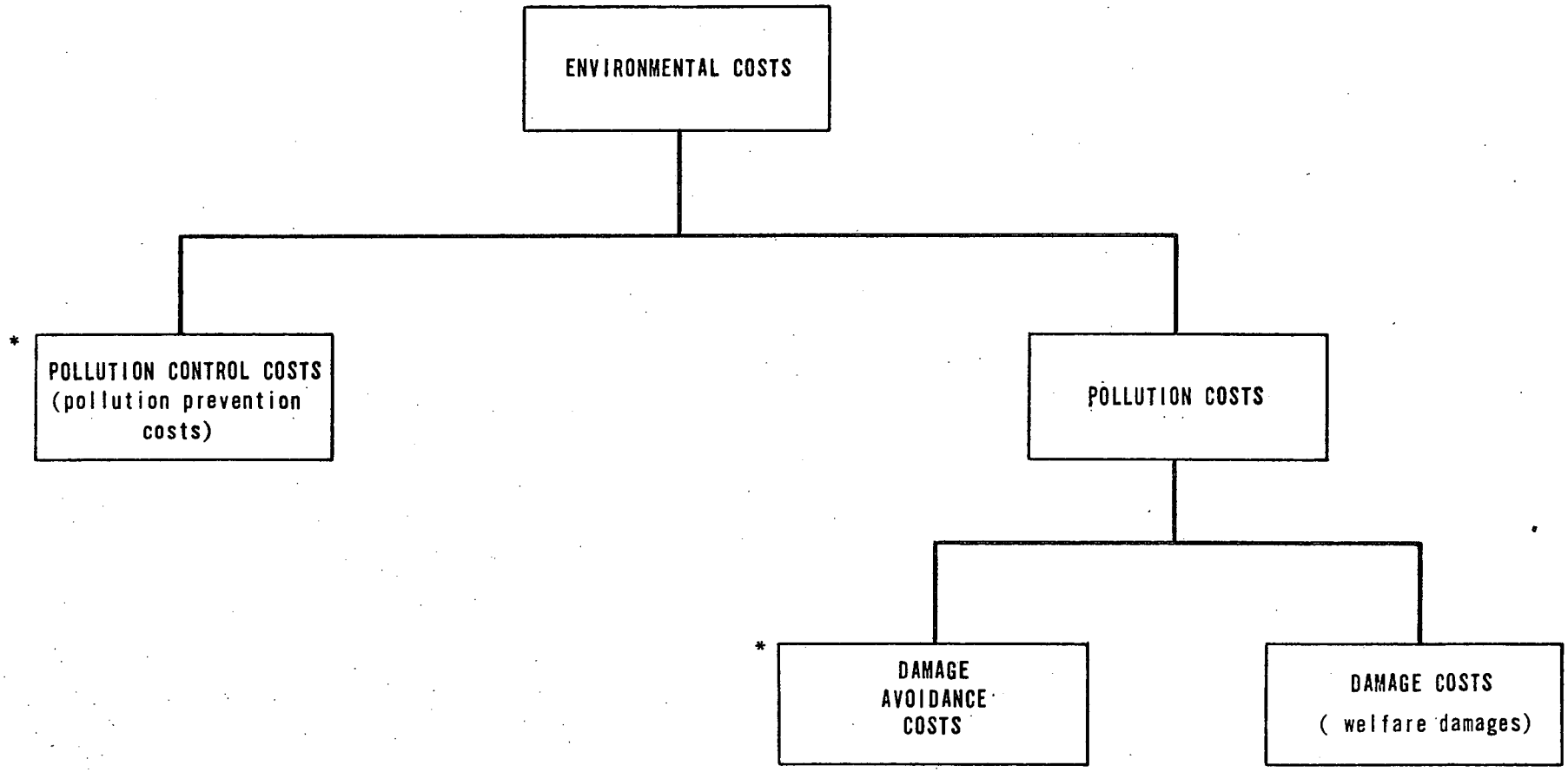


Figure I

TYPES OF ENVIRONMENT COSTS



* These costs can be examined by three different methods.

Pollution control costs refer to the "amount of money spent by public bodies or private parties to prevent some of the damaging or noxious effects of wastes."[4] It is the cost of preventing pollution per se and not the cost of preventing merely the harm that pollution causes. An example is the treating of sewage by municipalities.

Pollution costs, on the other hand, are "the money value of the damages caused by wastes after they are released into the environment ..."[4]

Damage avoidance costs, which can be incurred either by the government or by private parties, are "expenditures to prevent pollution damage ..."[4] Such expenditures prevent the harm that pollution causes, but not the pollution itself. An example is the treatment of municipal water supplies.

Damage costs are the "money equivalent of the reduction in welfare resulting from pollution damage that is not prevented."[4] An example would be the loss of swimming facilities due to the closing of local beaches on account of pollution.

A comparison of our conceptualization (Figure 1 with Appendix I) will show that the three rows in each figure are almost identical, while a comparison of Figure 2 with Appendix II will show that the second row of Figure 2 is a slight modification of E.P.A.'s conceptualization).

*Catch-up costs** refer to the additional costs which are

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* These terms will be discussed in more detail later in this paper.

necessary to meet present environmental standards. *Expenditures** include catch-up costs and the costs which are already being incurred. These costs are the type which are usually announced and publicized; however, they can be misleading and therefore for certain purposes we prefer the concept of *annualized costs.** These are made up of operation and maintenance costs, interest expenditures, and depreciation expenses, and better represent the true cost to society.

The bottom two rows of Figure 2 represent a slight departure from the usual economic tradition. Costs are normally divided into *public sector costs* and *private sector costs*, the former referring to costs incurred by governments at all levels, and the latter to the rest of society, i.e., all private persons and business firms. However, our policy modelling has indicated that a more useful breakdown is into *public sector costs* and *industrial sector costs* with "public" meaning government plus private individuals, and "industrial" referring to business firms. The major reason for this division is the fact that both government and private costs both tend to depend more on the population level. The cost of municipal sewage treatment plants is an example of a private and/or government cost that is closely tied to the population level. Costs to the industrial sector are usually closely related to the annual production rate of society.

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* These terms will be discussed in more detail later in this paper.

3. Expenditures and Catch-up Costs

As defined earlier, *expenditures* consist of costs already being incurred plus the additional costs required to meet existing environmental standards. As can be seen in Figure 2, both pollution control costs and damage avoidance costs can be expressed in the form of expenditures.

Expenditures include the initial capital investment, the interest charges, plus the operation and maintenance costs actually incurred during a period of time. This period of time could be any period of time, but is usually a few years, e.g., 5 years or ten years. This time period usually corresponds to the period which is required to put all the capital equipment into place.

As mentioned earlier, *catch-up costs* are similar to expenditures, except that they exclude any costs that are currently being incurred. Thus, they are the costs that must be met to close the gap between the existing environmental standards and the actual level of environmental damage protection (either through pollution control or damage avoidance).

Knowledge of *expenditures* and *catch-up costs* is needed to assess the short run economic impacts of closing the gap between the required/desired level of environmental protection and the actual level.* Once this gap has been closed, then *expenditures* will tend to approximate *annualized costs* which are actual accrued costs for a one-year

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*While analyzing the short term situation, changes in environmental quality, standards and technological improvements need not be considered although they are recognized as factors to be considered when analyzing a long-term strategy.

period. While there is a shortfall, however, expenditures will exceed annualized costs and can result in substantial effects on particular industries,* the money market, local economies, etc. Compensatory measures may have to be taken to mitigate such effects, provided that they are indeed only short run effects. Assessment of the long run effects of environmental standards should, of course, be a prerequisite for short term analysis. A strategy should be viable on a long term as well as on a short term basis to be considered for implementation. This will be discussed in the next section on *annualized costs*.

4. Annualized Costs

Whereas *expenditures* are conceptually similar to the "cash basis"[5] of accounting, *annualized costs* are conceptually like the "accrual basis."[5] Thus, *annualized costs* are made up of costs or expenses that actually accrue during the year in question. These usually consist of depreciation of capital expenses, operation and maintenance costs, and debt charges.

The advantage of accrued (annualized) costs are, that firstly, they enable a comparison with the benefits received during the same period of time and, secondly, they permit an assessment of the burden over the long run. Comparison of benefits and costs will be discussed in the next section, entitled "The Trade-offs."

Looking at a second advantage of *annualized costs*, we find that they are necessary to evaluate environmental costs on a long term

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*The raising of this additional capital (expenditures), which often contributes nothing to a company's profit margin, presents a real and genuine concern to many industries.

basis. While it is important to know what cash flow is needed in the short run, it is even more important to know the accrued costs that can be expected in the long run. When the sum of the public and the industrial sectors is related to the total revenue of society (GNP), we obtain an idea of the burden to be expected for a given set of environmental standards. Furthermore, it tells us whether this burden can be accepted according to our present and/or expected value system. For example, it can be compared to other major social programs such as health, welfare, education and defence to put the burden in perspective. Only after a proposed program of pollution control has been found acceptable in the long run, should the short run problems of initializing be studied. That is, if we are not prepared to carry the burden in the long run as expressed by the annualized costs, there is no point in studying the expenditures and catch-up costs that will be incurred in the short run. However, this is not to say that nothing should be done in the interim but rather that research should be directed towards viable long term solutions rather than expedient short term measures.

5. The Trade-offs (Benefits and Costs)

As stated in the previous section, *annualized costs* enable a comparison of benefits and costs during the same period of time. This is particularly important since the usual practice in benefit cost analysis of comparing total benefits and total costs at a particular point in time (through discounting), is not appropriate when the benefits are of an indefinite duration, as they often are in environmental protection projects.

The benefits in an environmental protection project are the costs saved. Thus, the trade-offs involved in *environmental* decision-making are, in the first instance, between *pollution control costs* and *pollution costs*. The benefit-cost ratio then would be:

$$\frac{\text{pollution costs (to be saved)}}{\text{pollution control costs}}$$

The trade-off is illustrated graphically in Illustration I. The problem is to minimize the *environmental costs* which means minimizing the sum of pollution control costs and pollution costs. As can be seen from the graphs, there is, for any particular project, some optimum degree of treatment of wastes where the environmental costs are at their minimum point.

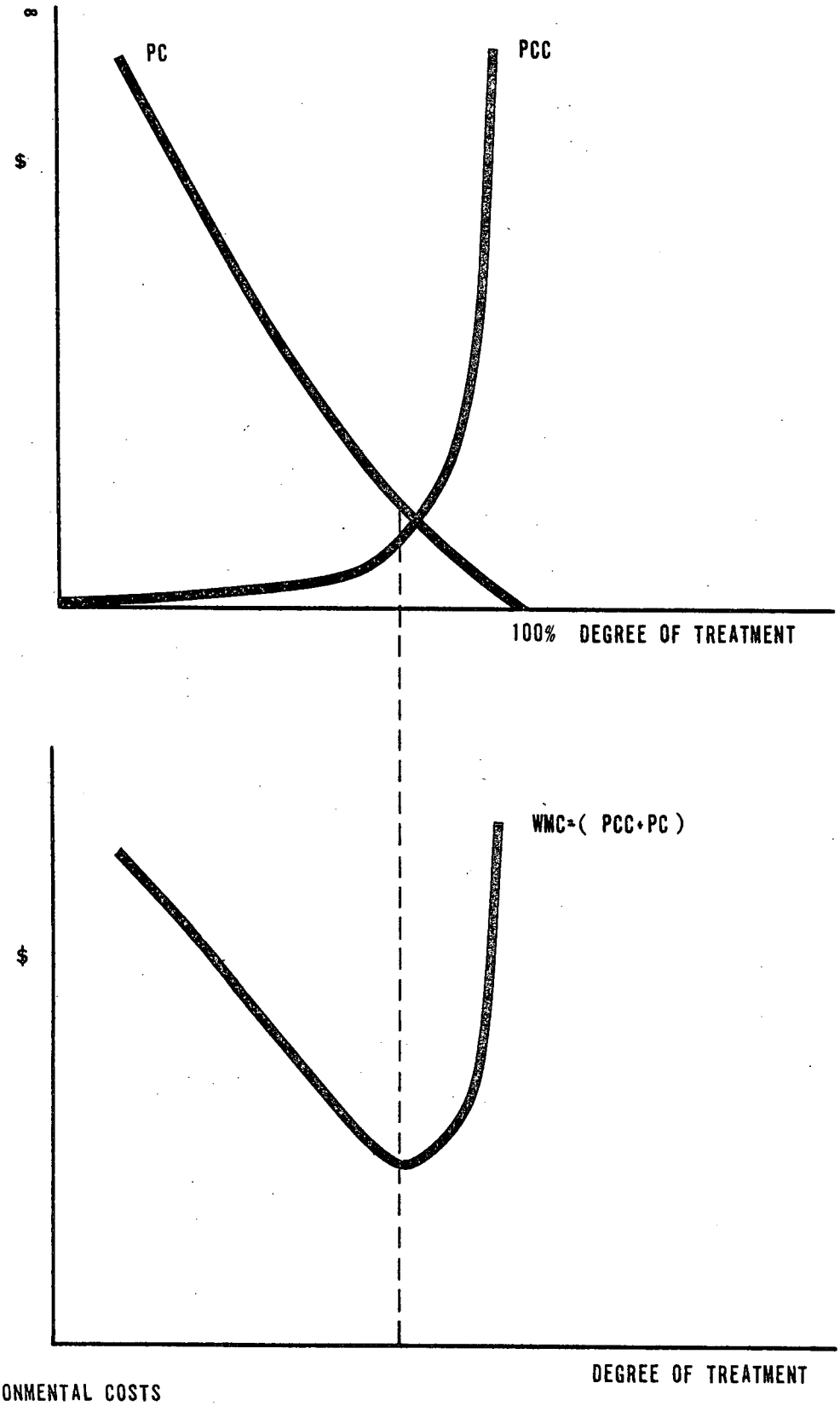
The presentation of the trade-off, so far, has been over-simplified. The real trade-off is often a threefold one, since pollution costs can take the form of *damage avoidance costs* or *damage costs*. Thus, the trade-off problem is essentially a case of trying to minimize the sum of the three costs involved, i.e.,

min. (pollution control costs + damage avoidance costs + damage costs.)

6. Direct and Indirect Costs (debt charges)

Costs are sometimes divided into direct and indirect costs. All cost estimates include direct costs, while some estimates exclude or express separately the indirect costs or debt charges. A *debt charge* can be defined as the interest and other charges payable on an amount of borrowed capital. The U.S. Environmental Protection Agency, and other U.S. agencies, have brought out this distinction (direct/indirect) in some of their pollution control costs estimates.[2] Unfortunately, no

Illustration I
GRAPHICAL PRESENTATION OF
ENVIRONMENT COSTS TRADE OFF



WDC - ENVIRONMENTAL COSTS

PC - POLLUTION COSTS

PCC - POLLUTION CONTROL COSTS

reason is given for this, although it is assumed that the uncertainty of any estimate of debt charges is a determining factor. Therefore, we have made a similar distinction for this reason and others.

At the theoretical level, the distinction is made between *pollution control costs* and *damage avoidance costs* on a national scale for reasons similar to those used by economists concerning the burden of the national debt.[6] That is, (assuming the money for capital expenses is borrowed in Canada) then the debt is a debt owed to ourselves and thus not a burden to the economy as a whole. This argument, of course, does not apply at the level of a single plant or industry.

From a pragmatic point of view, when forecasting costs, it is relatively simple to allow for changes in the overall price levels by forecasting in terms of constant dollars, except for the price of money (i.e., interest charges). The problem with interest charges* results from the fact that charges for the use of money are based on a percentage rate rather than a fixed dollar rate. This means that holding the dollar constant will not allow for changing interest rates. A forecast of the interest rate(s) for the period under concern is needed. However, forecasting interest rates is rather complex, especially for any length of time into the future, and will affect all cost estimates more or less uniformly. Therefore, in lieu of predictions by specialists in this area, a series of interest rate simulations (sensitivity analysis) is suggested.

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*Used in this paper interchangeably with *debt charges*.

Pollution control costs and damage avoidance costs should be presented in the form of *direct* and *indirect costs* or with and without *debt charges*. We are aware, however, that there is much controversy over this point. Some people want the debt charges included as an integral part of the cost estimates whereas others prefer dropping debt charges and using the economist's concept of *social time preference* instead. It will take much time and discussion to resolve this problem and, in the meantime, we feel the best thing is to present the *direct costs* plus some sort of indication of the indirect costs involved.

7. Transaction Costs

A final type of environmental cost, which is often neglected in cost estimations, is what the U.S. Council on Environmental Quality has termed transaction costs. *Transaction costs* are "the costs of research, development, planning, monitoring, and enforcement needed to achieve environmental goals and standards."[7] Such costs are of a fixed nature and represent a sub-category of pollution control costs and damage avoidance costs which are conceptually different from the other costs discussed and therefore are not covered in detail in this paper. However, they should be of obvious interest to the Department of the Environment, since the part of DOE's budget and that of the provincial environment ministries allotted to environmental management would comprise the bulk of this cost.

Transaction costs may be compared to a type of fixed environmental cost with respect to the society rather than to individual plants, industries or municipalities, i.e., society's overhead. These costs can generally only be related to the overall benefits corresponding

to pollution control costs and/or damage avoidance costs, and not to particular situations such as that of the individual plant or industry. Furthermore, the relationship between costs and benefits is often vague, e.g., the results of research efforts into pollution control technology are not evenly distributed over time or directly relatable to specific projects.

8. General Problems

Whenever *environmental costs* are presented, confusion and misunderstanding result for a number of reasons. Some of the conceptual problems have been covered briefly in this paper. Below is a list of points to consider when preparing or using environmental cost estimates. These points were first raised in an earlier paper[8] and show the difficulties involved in comparing different estimates or in making an estimate comparable.

1. Some cost figures are based on achieving an adequate level of environmental quality; others on a feasible level.
2. Even when the figures are clearly based on one of the criteria above, the standards sought vary.
3. Some figures represent *expenditures*, others, *catch-up costs*, and still others, *annualized costs*.
4. For *expenditures* and *catch-up costs*, the periods covered may vary (e.g., 1974-1980 or 1975-1985).
5. In the case of annualized costs, the period of depreciation may vary.
6. Some figures are based on capital expenditures only, ignoring operation and maintenance costs and/or interest charges.

7. Some estimates deal with the public sector only; others, the private sector only; others include both, and still others, the public sector and part of the private sector.
8. The categories of *environmental costs* vary considerably (e.g., solid waste management costs are often not included in so-called "total" cost estimates).
9. The degrees of accuracy vary, both between different authors and internally, among the various categories of environmental cost estimates.
10. Biases - from author to author, and agency to agency - vary.

Despite all the problems with environmental cost estimation listed above, estimates must be attempted if society and its decision-makers are to have the information needed to understand adequately the trade-offs involved. The first estimates at the aggregated (i.e., national) level have been crude and will continue to be so. With usage, they should become more refined (and the concepts behind them as well). However, like the more conventional social accounts currently in use (e.g., GNP), they can never be measured accurately or adequately enough for all people and all purposes, and thus will always be at the <u>developmental level</u>.

APPENDIX I

Dales' Conceptualization[1]

Figure 3 presents a diagrammatic summary of J.H. Dales' conceptualization of waste disposal costs. Dales defines *wastes disposal costs* as the total costs incurred by society to dispose of its wastes. These total costs are separated into pollution prevention costs (the same as our pollution control costs), and pollution costs.

Pollution prevention costs being the money spent to eliminate or reduce pollution at its source. Two examples would be - the cost of emission control devices on automobiles, and the costs of municipal sewage treatment plants.

Dales defines *pollution costs* as the costs caused by pollution after its release into the environment. These he broke down into pollution damage costs and welfare damage costs. Note that these concepts correspond directly to our breakdown of pollution costs under our headings of damage avoidence costs and damage costs.

Pollution damage costs are the monies expended to eliminate the damage pollution causes, but not to alleviate the existence or the cause of that pollution itself.

Damage costs are expressed in money equivalent terms since these costs are the result of damage caused to human welfare by unabated pollution. An example being the loss of swimming facilities due to the closing of local beaches on account of pollution.

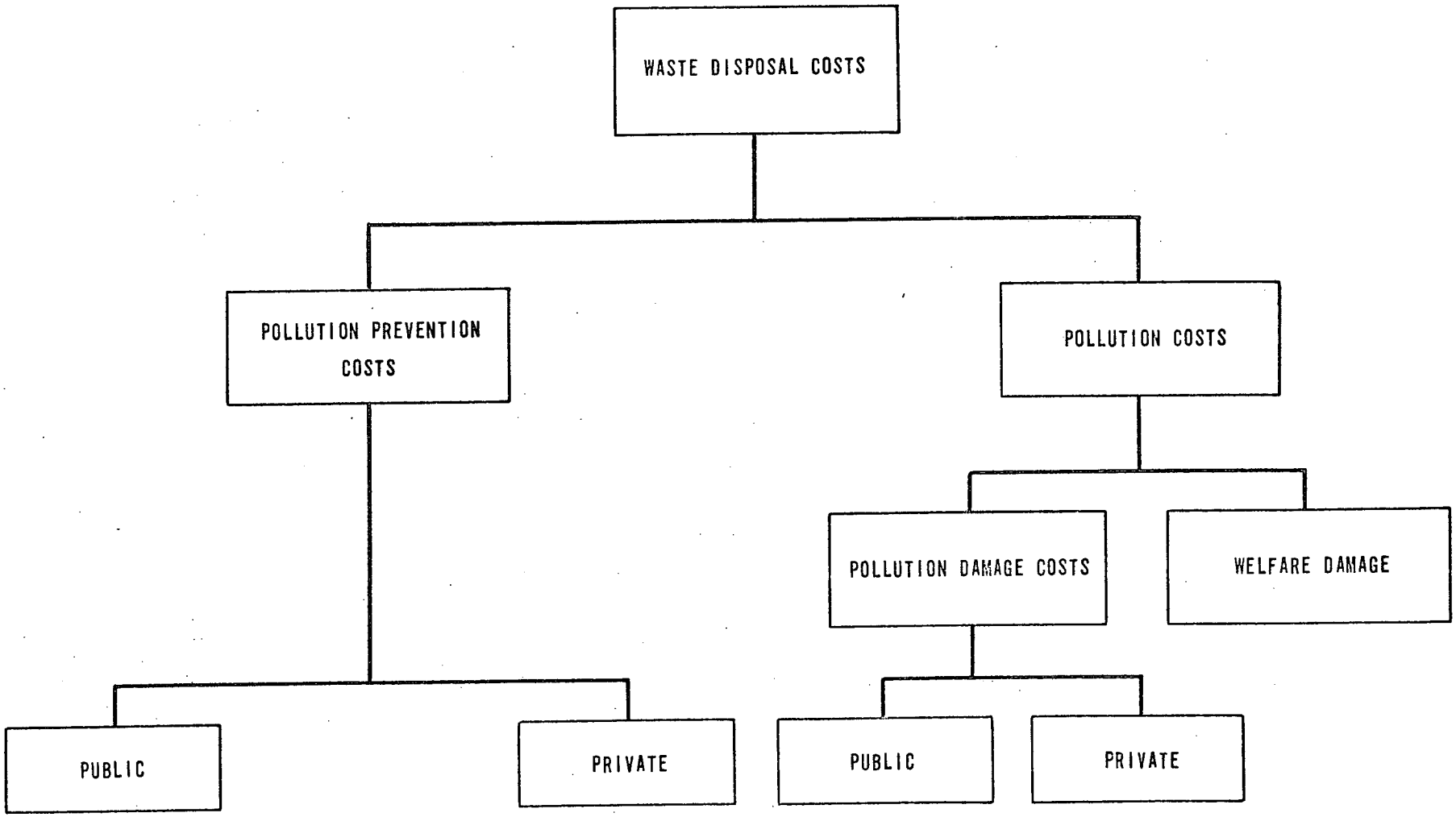
Dales has maintained economic traditions by subdividing both pollution prevention costs and pollution damage costs into public and private sectors. The *public sector costs* being those incurred by govern-

ments at all levels; *private sector costs* being those incurred by the rest of society (including private persons and business firms).

Figure 3

TYPES OF WASTE DISPOSAL COSTS

(Dales Conceptualization)



E.P.A.'s Conceptualization[2, 3]

The U.S. Environmental Protection Agency has, in its presentations of the economic impact of pollution control, expanded upon the concept of *pollution prevention costs* (see Figure 4). E.P.A. usually terms these costs *pollution abatement costs*. The term *pollution control* is also used. Figure 4 presents the diagrammatic summary of the E.P.A. conceptualization of pollution abatement costs. The same illustration can be applied for both *total pollution abatement costs*, which are similar to our concept of expenditures, i.e.,they include the costs that are already incurred, plus the additional costs required to meet existing environmental standards, and for *incremental pollution abatement costs*, which are the same as our catch-up costs, i.e., the additional costs necessary to meet present environmental standards.

E.P.A.'s total pollution abatement costs can be expressed either by *total cash costs* (for pollution abatement), which consists of the *investment outlays* plus the *annual costs*, minus *depreciation* for the period under consideration or as *total direct costs*, which are the total cash costs minus *interest* for the period.

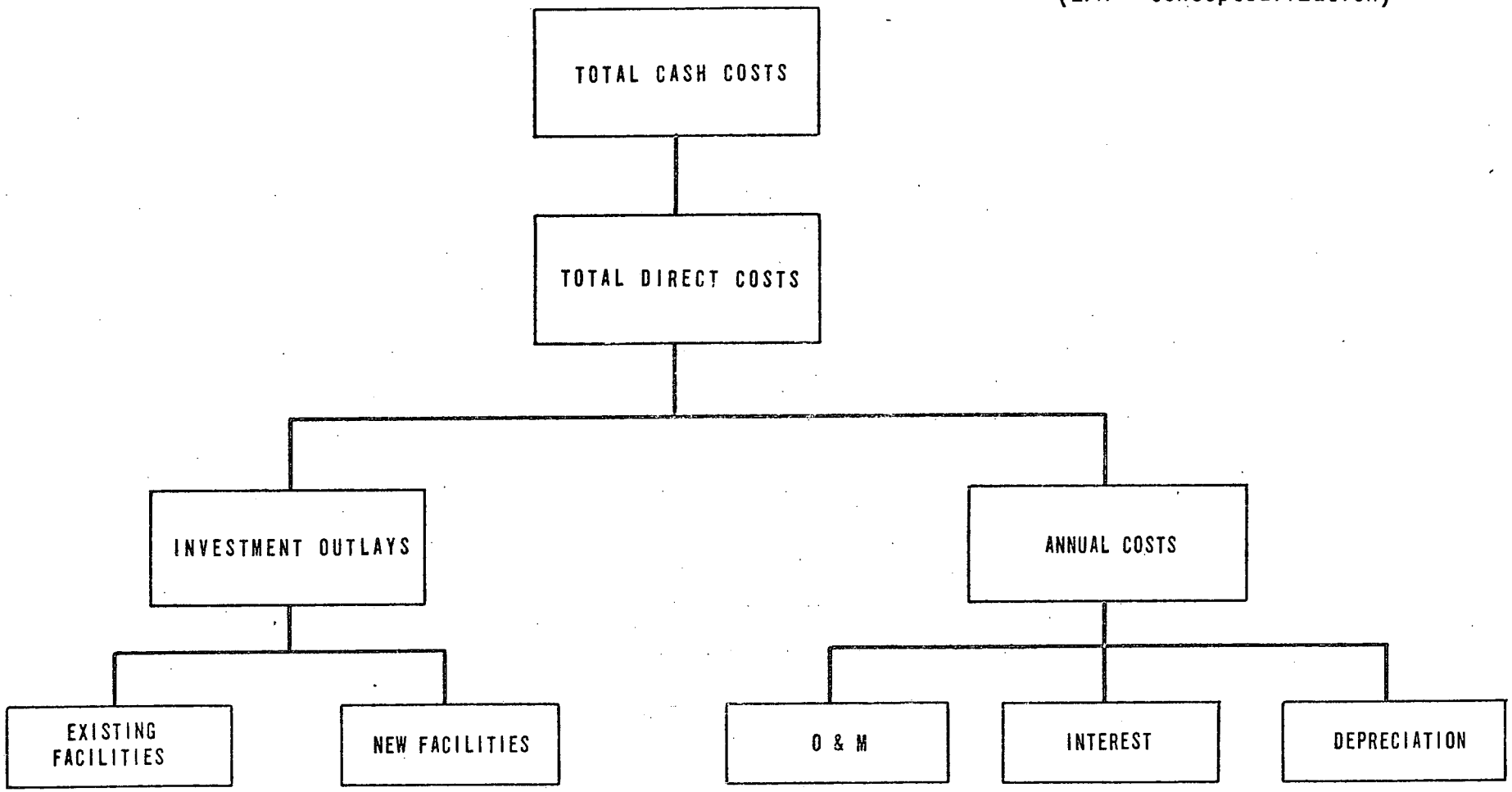
Investment outlays comprise the capital expenditures for both existing facilities and new facilities, while E.P.A.'s treatment of *annual costs* is identical to ours, that is, they include *operation and maintenance costs*, *interest expenditures* and *depreciation expenses*.

Figure 4

TYPES OF POLLUTION ABATEMENT COSTS

TOTAL or INCREMENTAL

(EPA'S Conceptualization)



Notes

(1) J.H. Dales, *Pollution, Property and Prices*, University of Toronto Press, 1968, Chapters II and III.

(2) *The Economic Impact of Pollution Control: A Summary of Recent Studies*, prepared for the Council on Environmental Quality Department of Commerce, and Environmental Protection Agency, Washington, March 1972.

(3) *Environmental Protection Agency, A Progress Report, December 1970 to June 1972*, U.S. Environmental Protection Agency, November 1972.

(4) Dales, ibid, chapter 2.

(5) Meirs, W.B., et al., *Intermediate Accounting*, Canadian Edition, Chapter 2. McGraw-Hill, Toronto, 1966.

(6) Paul A. Samuelson and Anthony Scott, *Economics, An Introductory Analysis*, Second Canadian Edition, McGraw-Hill Company of Canada Ltd., 1966, pp. 402-403 and pp. 412-416.

(7) *Environmental Quality*, the Fourth Annual Report of the Council on Environmental Quality, Washington, September 1973, p. 83.

(8) E.R. Tinney and P. Maniate, "Economic Considerations for Cleaner Air at the International Level," *Proceedings of the Air Pollution Control Association (Quebec Section), Cleaner Air: Cost-Benefits*, May 28-30, 1972, Montreal, Quebec, pp. 50-51.

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