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Demeter Group and Roy F. Weston, Inc.
Eco-efficiency

Measuring Eco-efficiency in Business: Developing and Implementing Pollutant Dispersion Indicators

Results of the Feasibility Study Workshop January 26 & 27, 1998

Toronto, Canada

Prepared for

National Round Table on the Environment and the Economy

Prepared by

DEMETER GROUP
AND
ROY F. WESTON, INC.

West Chester, Pennsylvania 19380-1499

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PREFACE

This document summarises the results of a workshop convened by the National Round Table on Environment and Economy on January 26 and 27th, 1998, to develop a pollutant dispersion indicator (PDI) that can be used to help corporations track progress toward eco-efficiency. At the workshop representatives of several companies and a number of invited experts, discussed the feasibility of developing and pilot testing such an indicator. There was agreement on the purpose of a feasibility study, the general characteristics of a PDI, and the criteria a useful indicator should meet. Building on the results of previous NRTEE workshops and background papers, the participants developed the draft PDI presented in this document. The purpose of this document is to provide a record of these areas of agreement, describe the PDI, and to provide the workshop participants with a document that may be used as a starting point to evaluate the feasibility of a PDI.

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1. BACKGROUND

In the document *Science and Technology for the New Century: A Federal Strategy*, the federal government set out its policy response to the Science and Technology Review. With the aim of achieving sustainable development through innovation, the federal government sought the advice of the National Round Table on the Environment and the Economy (NRTEE) with regard to establishing specific targets to help industries and other sectors become significantly more eco-efficient. They also asked NRTEE to examine the implications of those targets for the development of new technologies. Reaffirming this objective, the Liberal Party in its 1997 plan, *Securing Our Future Together*, stated that the NRTEE would be asked to "expand its work with stakeholders and provincial governments to develop eco-efficiency indicators."

In response, the NRTEE's Eco-efficiency program is developing a system of performance indicators that will assist companies in developing and implementing a set of measurable eco-efficiency indicators.

On April 2, 1997, in Washington, D.C., by invitation of the NRTEE and World Business Council on Sustainable Development (WBCSD), leading representatives from industry, non-government organizations (NGOs) and government met to discuss their experiences in measuring eco-efficiency and to reach conclusions on the feasibility of developing and implementing a core set of eco-efficiency indicators. These individuals came from organizations in Canada, the US, Mexico, Colombia and Switzerland; many had also worked extensively in other countries or were involved in work concerning developing countries; all were practitioners and thinkers in the areas of eco-efficiency, performance measurement and business policy.

The workshop participants agreed that the development and testing of indicators for material and energy intensity held the greatest promise[1]. The workshop participants also discussed the feasibility of developing a toxics release index. They agreed that developing such an index would be problematic due its dependence on value based weighting factors and data limitations. They did, however, agree that relevant indicators for toxic releases could be devised using currently available data. The workshop report concluded that:

> *Development of one or more indicators for toxic dispersion or releases was also considered to be both highly desirable and relatively feasible, since it is likely that toxic release data pertaining to specified substances is already routinely tracked and recorded by companies under existing domestic laws (in some countries) and international treaties (in many countries).*

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[1] As a first step in testing the feasibility of these indicators the NRTEE held a workshop on November 12-14, 1997, with eight volunteer companies. At the workshop material and energy intensity indicators were designed and subsequently all eight companies have agreed to test the indicators within their organizations.

Detailed discussion on the toxic release index is contained in the NRTEE Backgrounder publication *Measuring Eco-efficiency in Business.* The workshop participants recommended a number of follow-up actions such as; better defining the scope of the indicator, developing a list of specific chemicals, reviewing models/methodologies for measuring toxicity and for reporting toxic emissions and conducting field trials.

As a first step in carrying out these recommendations the NRTEE commissioned a discussion paper entitled *International Performance Indicators for Dispersion of Toxic Chemicals into the Environment*[2]. The paper reviewed possible means to develop pollutant dispersion indicators. It examined current pollutant release and transfer registers and it made the following observations:

- the essential element of a pollutant dispersion indicator is the annual quantity of toxic substances released by an organization per unit of production or business activity;
- the approach used by the Canadian Accelerated Reduction/Elimination of Toxics (ARET) program provides the most applicable model for classifying toxic chemical substances;
- although there are models for weighting or ranking toxicity of chemical substances these schemes are somewhat arbitrary in their allocation of weighting factors; and
- the quality and reliability of quantitative release data can vary, therefore the methodology for calculating releases will require careful attention.

To further explore the development of a pollutant dispersion indicator the NRTEE held a workshop on January 27-28th, 1998, with several volunteer companies and a number of invited experts. The companies came to a number of areas of agreement on the design of a pollution dispersion indicator and they further agreed to review the results of the workshop and consider the possibility of a feasibility study going forward. This report summarizes the results of that workshop.

2. PURPOSE OF THE FEASIBILITY STUDY

The overall purpose of the study is to test the feasibility and value of indicators to support the goal of eco-efficiency. Workshop participants also agreed to the following statements in regard to the development of pollutant dispersion indicators.

- The indictors developed should help companies engage in an intelligent dialogue both within the company, and with outside stakeholders.

- Indicator(s) developed will assess the release of pollutants to the environment not the reduction of use.

[2] G. Peter Robson. *Discussion Paper on International Performance Indicators for Dispersion of Toxic Chemicals into the Environment.* Prepared for the National Round Table on Environment and Economy. October 1997.

- The list of pollutants used in the feasibility study will follow the decision rules agreed to by the participating companies.

- The list of pollutants for the feasibility study will be created from existing credible lists of pollutants as agreed to by the participating companies.

- For the feasibility study, the list will recognize different levels of concerns outlined in ARET.

- The intention of the feasibility study is to take a proactive approach to the development of an eco-efficiency indicator(s) for pollutants.

These statements were useful to the participants to help guide the development of information and approaches outlined in this report.

3. CRITERIA FOR PDI INDICATOR

Before the participants could define the indicator, considerable effort was made to make sure there was a common understanding of the criteria to be used to develop the indicator. The following criteria were used to assist the participants in establishing the PDI:

- Useful as an analytical tool and easy to reproduce from year to year.
- Adaptable – capable of being modified over time (that is capable of accommodating new substances provided they have met established criteria for inclusion or have been scientifically evaluated in an open and transparent process).
- Credible to stakeholders, users and respond to external concerns.
- Allow for sector-specific indicators and be applicable to different countries and regions.
- Auditable.
- Relevant to both organic compounds and inorganic compounds.
- Complement existing energy and material indicators and other eco-efficiency tools.
- Simple to use and understandable by audiences representing broad technical and non-technical backgrounds.
- Be robust information sources for improvement i.e. clear, relevant, accurate, scientifically sound, unambiguous, and representative regardless of context. It is an essential corollary that the use of these indicators for decision-making not result in reduced eco-efficiency or increased environmental impacts, elsewhere in the system.

- Valuable at several levels within the company, including business unit, regional and corporate level for applications such as, setting goals, assessing progress and continual improvement (see Figure 1).

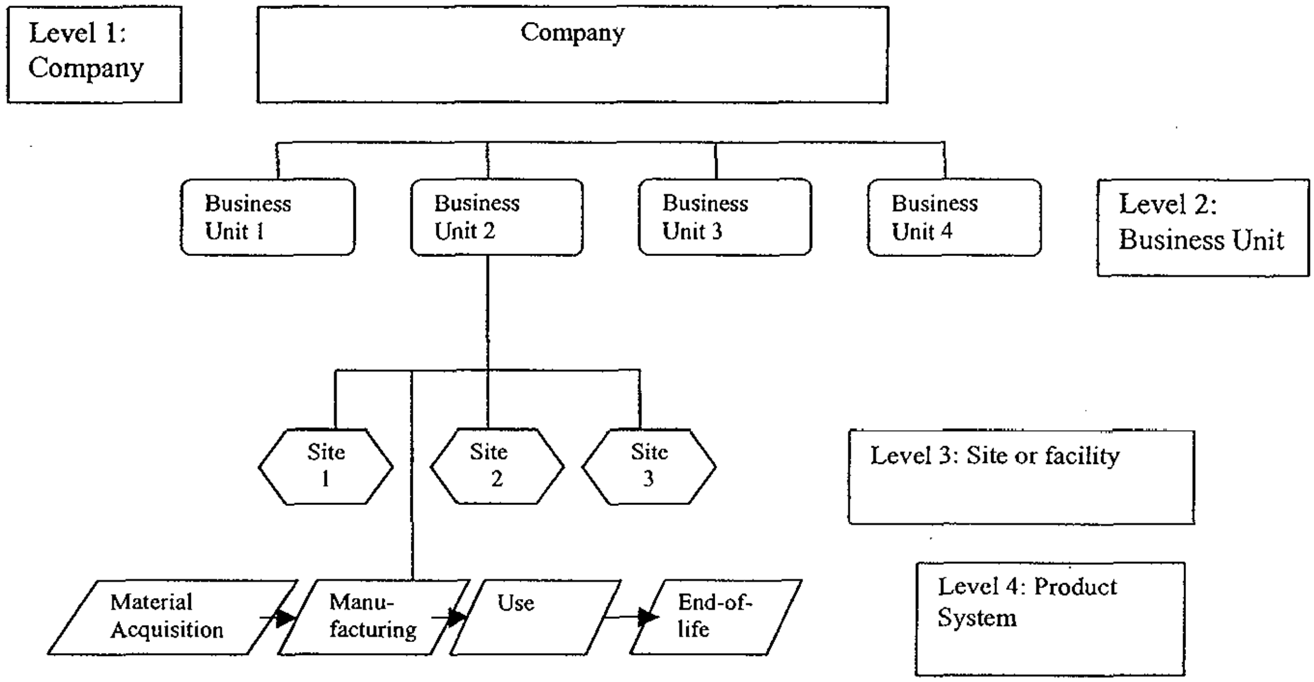


Figure 1: Levels within a company at which indicators can be applied.

- The methodology for developing the indicator(s) should provide principles, rules and guidance for the transparent inclusion and exclusion of the data, measurements and assumptions used to derive indicators.

- The data and measurements for the indicators should either be available or obtainable in a cost-effective manner.

4. AUDIENCE (S) FOR ECO-EFFICIENCY INDICATORS

Potential audiences for the indicators developed under the feasibility study are:

1. Internal to companies (e.g.,)
   - Business sectors and product development groups
   - Strategic management groups
   - Product design –material selection
   - Other company organisations – e.g., environmental quality
   - Employees

2. External - other stakeholders (e.g.)
   - Customers
   - Financial institutions
   - Competitors
   - Suppliers (material/parts -- influenced by customers and product designers)
   - Governments
   - Non-governmental organizations (NGOs)
   - Communities and general public

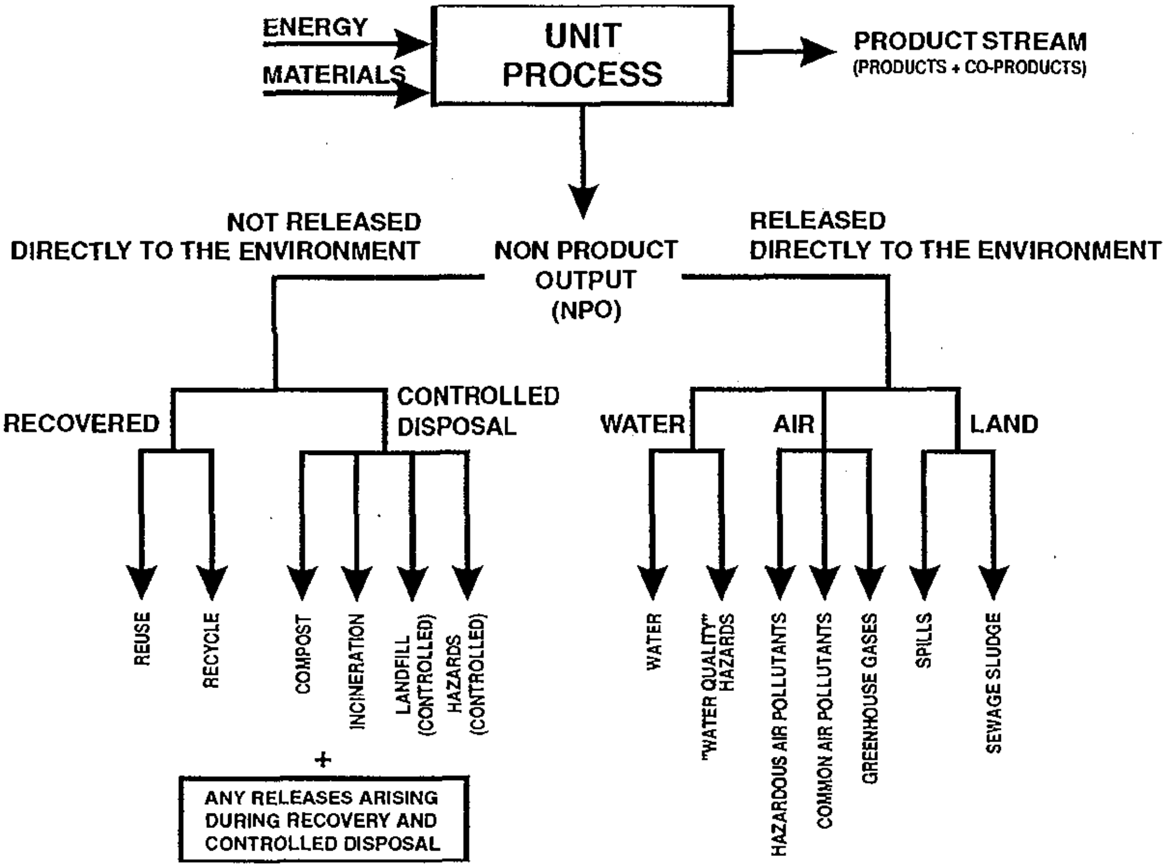
In addition, there are a number of potential co-developers of eco-efficiency indicators where formal liaisons may be useful (e.g.,)

- World Business Council on Sustainable Development
- Industrial Pollution Prevention Council
- Center for Waste Reduction Technologies
- World Environment Center

5. INDICATOR SET

Figure 2 illustrates the broad range of releases, or non-product output, that can occur from a unit process. For the purposes of this feasibility study a unit process can be assumed to be the smallest portion of the product or service system for which data are collected. For a manufacturing company, this is often the manufacturing site. For a service company this may be a processing facility (e.g., switching station).

Figure 2: Non-Product Output of a Unit Process



Non-product output encompasses substances that are released directly to the environment, substances that are returned to a production system through recycling or reuse, and substances which are transferred to various controlled disposal options such as a hazardous waste facility or an incinerator. This feasibility study is primarily concerned with pollutants released directly to the environment. Additional complementary indicators are suggested for participants who may also wish to identify and measure pollutant "transfers" to controlled disposal. As with the material and energy intensity indicators, this will provide the users, if appropriate, with an opportunity to provide a more complete picture of their activities.

A further consideration for pollutants released directly to the environment are pollutant releases that occur during the handling and treatment of substances that are reused, recycled or sent for controlled disposal. This can be viewed as indirect releases, which are attributed to the original companies' generation of the non-product output. Where such information is available it should be considered in the calculation of the indicator.

Minimum Indicator Set

Each of the participating companies will test the feasibility of the following indicators.

1. Mass of pollutants releases per unit of output

Where unit of output is defined as a unit of production measure, or a unit of revenue. All participating companies shall report the indicator using a unit of production as the denominator. If appropriate a denominator based on a unit of revenue (e.g., value added), should also be reported.

Pollutant releases (the mass of pollutants released for the defined manufacturing process or service) for the minimum indicator, are substances common to the following lists:

- The Toxics Releases Inventory (TRI)
- The National Pollutant Release Inventory (NPRI)
- The Accelerated Reduction and Elimination of Toxics (ARET) list

The intersection of these lists is illustrated in Figure 3. For the minimum indicator, the substances occurring in sections A, B and C of Figure 3. are to be included as part of the indicator. A list of these substances is provided in Appendix B. A total of 198 substances are included in this minimum indicator.

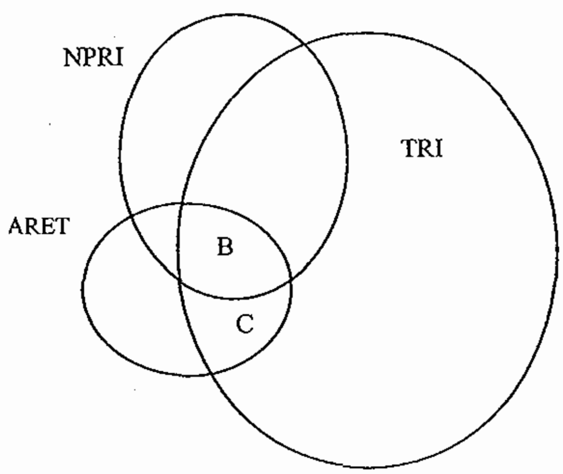


Figure 3. Illustration of pollutants to be reported in the minimum indicator set.

2. Mass of pollutants common to TRI and ARET (placed in the ARET classification scheme) per unit of output.

This second indicator was developed to allow participating companies to differentiate pollutant releases based on a classification system that categorises pollutants based on their environmental relevance. The indicator comprises pollutants in section B and C of Figure 3., grouped into the ARET classification system.

A list of these pollutants grouped into the ARET classification scheme is provided in Appendix B. The ARET classes (A1, A2, B1, B2, and B3) are a rank ordering of the pollutants based on their intrinsic properties.

To minimise the number of indicators a number of alternative groupings of the ARET classes were discussed at the workshop. The recommended approach is to add A1 and A2 substances together, leave B1 as a class by itself and to add classes B2 and B3 together. This aggregation step will result in three measures for the second indicator in the minimum set.

Note 1: For the purpose of the feasibility study the total mass for each of the groupings will be reported. With this basic data the participating companies can test and evaluate other approaches. For example - total mass of all groupings assuming an equal weight among all groupings or total mass using alternative weighting factors for each grouping.

Note 2: A reality check will be conducted, by each company to determine, which other significant chemicals of concern are not captured. For example, a check to ensure that a manufacturing site is not releasing large quantities of a chemical, that is environmentally relevant but not included in the minimum set.

About ARET

ARET is a multi-stakeholder initiative dedicated to decreasing the adverse effects of toxic substances on human health and the environment. These effects are mitigated by accelerating the reduction or elimination of emissions of selected toxic substances.

ARET especially targets toxic substances that persist in the environment and bioaccumulate in living organisms. Through voluntary action, organizations that use, generate or release toxic substances strive to reduce or eliminate their emissions of these substances.

The ARET process screened two thousand substances to develop the ARET list of 117 toxic substances.

Source: Environmental Leaders 2 Accelerated Reduction / Elimination of Toxics Progress Report

Companies should look at the ease of collecting additional data on significant releases not included above; where this data is readily available companies are encouraged to evaluate the effect of this data on the indicator.

6. COMPLEMENTARY INDICATORS

In addition, to the pollutants identified in the minimum set, companies may wish to develop complimentary indicators in any of the following ways

- expand their pollutant list (i.e. add additional classes) to include, for example common air pollutants or greenhouse gas emissions;
- For companies testing the indicator within Canadian operations, add to the minimum indicator releases of other ARET and NPRI substances; and
- For companies testing the indicator within American operations, add to the minimum indicator releases of other TRI substances

Moreover any of the indictors developed can be measured at other life cycle stages including material acquisition and processing, transportation, use, and disposition (See level 4 in Figure 1).

For these complementary indicators the selection of the unit of output is identical to the minimum set.

7. RELATIONSHIP TO THE MATERIAL INTENSITY INDICATOR

In the NRTEE energy and material intensity feasibility study the material intensity indicator is defined as follows:

<u>Total material used directly in the product and co-product</u>
Total output of product and co-product

<u>Total material used directly in product and co-product + total indirect material</u>
Total output of product and co-product

Where input includes materials directly incorporated in the product and co-product, and indirect (ancillary) materials used in the manufacturing process to produce the product and/or co-products, but do not end up in the product or co-product. Materials include raw materials, packaging, and water (excluding non-contact water).

The pollutant dispersion indicator tracks a portion of the material flows that are not included in this measure - the non-product output (see Figure 2). For the material intensity indictor the following decision rule applies:

> All materials, which make up greater than 1% by mass of the products or co-products leaving the manufacturing site, will be identified. From this list, the materials that have a cumulative mass contribution of up to 90 % of the total weight of products or co-products would be included.

Companies who are testing both the PDI and the material intensity indicator will also wish to ensure that they are tracking the PDI pollutants regardless of whether they meet this decision rule. This will help streamline data collection, facilitate the measurement of the PDI, and will help link the material intensity and pollutant dispersion indicators.

8. DATA COLLECTION AND CALCULATION PROCEDURES

For all indicators used, each company will describe and document the data collection and calculation procedures, and the verification procedures used.

Each company is responsible for data collection and handling.

- Units: Pollutants will be reported in metric units (e.g. kg or tonnes)

- Allocation: If the indicators are normalised to a product or service, allocations based on mass will be used if multiple products are produced from the same facilities (e.g., different grades of paper from a mill).

- Time period coverage: Time period used for all indicators will be 1996 data – to the extent that is available earlier years (95, 94, 93...) may also be used. This information over several years will assist the users to evaluate the usefulness of the PDI to assist decision making.

- Thresholds: The reporting thresholds for both indicators in the minimum set will be those currently used in NPRI and TRI.

For the complimentary set of indicators, each company will document and report to the steering committee, the calculation procedures, assumptions, and decision rules used to include and/or exclude pollutants.

9. DATA QUALITY

This section specifies the general data quality requirements needed to meet the project goals. Data quality may be defined as the degree of confidence one has in the data. Every effort should be made by participants to collect high-quality primary data. Where primary data are not available, secondary or surrogate data may be employed.[3]

For each indicator, information regarding the source, nature, and quality of the data shall be reported by the respondent. Where possible, estimates of variability associated with the indicators should be considered and included. Data used in the feasibility study will also be characterised as to whether measured, calculated, or estimated values have been used. These latter indicators are defined as follows:

Measured: Primary data reflect actual measurements (direct sampling) performed during the subject time period.

Calculated: Measured values have been modified to reflect calculations by the process engineer based on process design and operation (report rationale especially where professional judgements and estimates are used).

Estimated: Any secondary data, design-based extrapolations to other facilities or processes or other theoretical calculation (report data source, any allocations, and rationale).

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3 "Primary" refers to data collected directly from single facilities; "secondary" refers to data acquired from reference materials or published studies. "Surrogate" data may be used where some information is initially missing or ill defined.

Additionally, qualitative and quantitative data quality indicators (DQIs) may be used. The following section outlines DQIs.

9.1 Qualitative data quality indicators

Consistency

Consistency describes how uniformly the methodology is applied not only across different processes and stages within a life cycle, but also to other products, systems, and services. Documentation of the assumptions, protocols, and transparency of the process is needed to ensure that the results can be reproduced.

Consistency is assessed by reviewing how tools or procedures (including such things as process flow diagrams, boundary descriptions, templates, normalization and/or aggregation methods, calculations and computer procedures) are applied.

It should be noted that while consistent techniques may be used, diverse results may still be obtained for reasons including the use of different raw materials or different processes. It is easy to misplace or misinterpret the position of process boundaries, which directly affect perceived quality.

Representativeness

Representativeness refers to the degree to which data values and results truly reflect the processes relevant to the indicator included in the study. The degree of representativeness may be judged by comparing data sets for similar processes within the study, and perhaps with sets of published data.

Where published studies are not readily available, an examination of the technological mix of the processes in the study is conducted to ensure that the production-weighted inputs of the various technologies are fairly represented.

Anomalies and Missing Data

Anomalies are extreme data values within a data set. Where a data value is suspect, more information should be obtained, if possible, to determine if the datum is within the expected range of the average value.

Missing data or data gaps are absent data values that are considered important. Where important data are missing, efforts should be made to fill these gaps with measurements or calculations, if possible. Otherwise, explicit and documented estimates may be used to fill the data gaps.

9.2 Quantitative data quality indicators

Completeness

Completeness evaluates the sets of primary data obtained relative to the number of data sets that might possibly be obtained. A measure of the completeness of a primary data category for each manufacturing unit is performed by dividing the number of reporting locations providing data by the number of locations which were solicited for data.

Precision

Precision is a measure of the spread or variability within a data set, expressed as a statistical mean and variance. Where more than three data points exist, a mean and an estimate of variability may be obtained. Such calculations are performed for each primary data category.

10. RESULTS VERIFICATION

Verification of the feasibility study process will be carried out through distribution of the workshop report to the NRTEE Eco-efficiency Task Force and representatives of the stakeholders identified in Section 4.

Although not part of this feasibility study, it is recognized that verification of the procedures used by the companies may be required in the future, as appropriate. Additionally the results of the feasibility study may also be verified by application to other companies prior to full-scale implementation.

11. COMMUNICATIONS PLAN

There are three proposed elements to a communications plan for the project. Ongoing communications of the feasibility project, internal communications between the participants, and communication of the final results.

For ongoing communications, a package will be produced for each participant, which includes:

- A overhead presentation describing the project, indicators, method, expected outcomes and business benefits of participating in the project;
- A one page communication note on the project, including who to contact for additional information; and
- Copy of the report from the January workshop.

For internal communications, a schedule for regular information exchange between participating companies will be developed. Whenever possible, electronic forms of communications will be used. When appropriate, follow-up meetings will be scheduled and project updates will be produced.

The third element of the communications plan for this feasibility study will be a strategy (agreed to by all participants) to communicate the final results.

12. COSTS

The feasibility project will endeavour to design the most cost effective approach possible. Participants are encouraged to complement existing measurement and management systems, and capitalize on opportunities to share information and costs. Where possible participants will document costs and business benefits associated with conducting the feasibility study. Considerations in determining the costs are labour hours, direct expenses, travel, and any consultancy (if used).

13. PLAN OF ACTION

The Steering Committee (SC) is comprised of representatives of each of the participating companies, as well as members of the NRTEE Eco-efficiency Task Force. It is essential to have one primary and one or more secondary contacts for each company. This will ensure that participation by the company continues, even when there is a conflict in scheduling interactions among the Steering Committee. It is proposed that the Steering Committee make decisions regarding this project on a consensus basis.

The proposed role of the Steering Committee is to:

- Oversee the implementation of the feasibility study.
- Be available to discuss and resolve issues brought up by the individual companies.
- Results of individual company efforts are presented to Steering Committee for final agreement and resolution of outstanding issues.
- Be available to resolve issues raised by the individual companies.
- Direct the preparation of outlines and divide up tasks related to the completion of the feasibility study.
- Direct the preparation of the final report.

The proposed role of the individual companies is as follows:

- Take the results of the January workshop (indicators, methodology framework and plan of action) and obtain appropriate approval and buy-in from the company.
- Be primarily responsible for data collection.
- Participate in the regular information exchange between participating companies and provide representatives to the necessary follow-up meetings.

- Be available to describe data collection efforts, and to follow-up and answer questions raised by Steering Committee.
- Finalize all data collection efforts.
- Assist in preparing draft sections of final report.
- Approve final report.

Table 1 sets out the schedule for the feasibility study.

Table 1: Proposed Schedule

Email Word 6.0 version of document + lists + communications piece to NRTEE	Feb. 5
Forward document to participating companies	Feb. 6
Comments from companies back to NRTEE + Go no go decision by companies	Feb. 13
Forward document to reviewers – let them know feasibility study is going forward and check significant concerns	Feb. 13
Response back from reviewers	Feb. 27
Initial data collection	Feb.-April
Reality Check SC meeting – firm up path forward, liaison with reviewers if appropriate	March 16.
NRTEE Eco-efficiency program communication session	March 17 Globe 98 Vancouver
PDI SC meeting – evaluate progress, map out next steps	June 25
Draft Final Report	1998….
Final Report	1998….

APPENDIX A: Notes regarding the chemical lists.

The following should be noted with respect to the chemical lists in Appendix B and C.

These comparison lists were compiled from the complete lists of TRI, NPRI and ARET substances obtained directly from the government agencies responsible for these lists. Matches for chemicals were based on CAS number to ensure accuracy. This is why the lists are ordered by CAS#, except for the metals. The lists handle metals differently. TRI lists elemental metals with associated CAS numbers; NPRI lists metals "and their compounds", with no CAS numbers; ARET lists inorganic soluble forms for metals generally, again with no CAS numbers. It was assumed that if copper is on one list, for example, it means essentially the same thing as copper listed on the other two lists.

The TRI list refers to PCBs as CAS# 1336-36-3, while the corresponding Canadian entry (only on ARET) has no CAS number. The CAS identification cell blank for these substances have been left blank. The individual lists contained the following total number of chemicals:

TRI = 581 NPRI = 178 ARET = 121 (116 individual chemicals + 5 group categories)

The ARET list contains several group categories of chemicals. These groups are the following:

Non-CAS ID	Chemical name	Group
PAH-A1	PAHs A-1 (not speciated)	A-1
PAH-B1	PAHs B-1 (not speciated)	B-1
PAH-B2	PAHs B-2 (not speciated)	B-2
TCDF/TCDD	2,3,7,8-TCDF/TCDD	A-1
NA12	PCBs	A-1

Only the PCB grouping is treated as a "substance" in compiling the lists in Appendix A and B.

In figure 2 - the Venn diagram, a + b + c = 196 substances

NPRI and TRI (or a + b):	165 substances
ARET and TRI (or b + c):	78 substances
ARET and NPRI and TRI (b only):	48 substances

One interesting fact to note. Although each list contains unique chemicals, the intersection of ARET + NPRI is the same as ARET + NPRI + TRI. In other words, there are no chemicals that are on both ARET and NPRI which are not also on TRI.

APPENDIX B: Chemical list for Indicator 1

TRI + (NPRI or ARET)

Substance	CAS Number
1,1,2,2-Tetrachloroethane	79-34-5
1,1,2-Trichloroethane	79-00-5
1,2,4-Trimethylbenzene	95-63-6
1,2-Butylene oxide	106-88-7
1,2-dibromo-3-chloropropane	96-12-8
1,2-Dichloropropane	78-87-5
1,2 dichloroethane	107-06-2
1,2 diphenylhydrazine	122-66-7
1,2,4-Trichlorobenzene	120-82-1
1,3 butadiene	106-99-0
1,3 dichloropropene	542-75-6
1,4 dioxane	123-91-1
2,4,6-trichlorophenol	88-06-2
2,4-Diaminotoluene (and its salts)	95-80-7
2,4-Dichlorophenol (and its salts)	120-83-2
2,4 dinitrotoluene	121-14-2
2,6 dimethylphenol	576-26-1
2,6 dinitrotoluene	606-20-2
2-Ethoxyethanol	110-80-5
2-Methoxyethanol	109-86-4
2-methylpyridine	109-06-8
2-naphthylamine	91-59-8
2-nitropropane	79-46-9
3,3' dichlorobenzidine	91-94-1
4,6 dinitro-o-cresol	534-52-1
4-aminoazobenzene	60-09-3
4-aminobiphenyl	92-67-1
4-nitrosomorpholine	59-89-2
Acetaldehyde	75-07-0
Acetamide	60-35-5
Acetonitrile	75-05-8
Acrolein	107-02-8
Acrylamide	79-06-1
Acrylic acid (and its salts)	79-10-7
Acrylonitrile	107-13-1
Allyl alcohol	107-18-6
Allyl chloride	107-05-1
alpha-hexachlorocyclohexane	319-84-6
Aluminum (fume or dust)	7429-90-5
Aluminum oxide (fibrous forms)	1344-28-1
Ammonia (Total)	
Aniline	62-53-3
Anthracene	120-12-7
Antimony (and its compounds)	
Arsenic (and its compounds)	
Asbestos	1332-21-4

Benzene	71-43-2
Benzidine	92-87-5
Benzoyl chloride	98-88-4
Benzoyl peroxide	94-36-0
Benzyl chloride	100-44-7
Beryllium	7440-41-7
Biphenyl	92-52-4
bis(2-chloroethyl)ether	111-44-4
bis(2-ethylhexyl)phthalate	117-81-7
bis(chloromethyl) ether	542-88-1
Bromodichloromethane	75-27-4
Bromomethane	74-83-9
Butyl acrylate	141-32-2
Butyraldehyde	123-72-8
C.I. Acid Green 3	4680-78-8
C.I. Basic Green 4	569-64-2
C.I. Basic Red 1	989-38-8
C.I. Disperse Yellow 3	2832-40-8
C.I. Food Red 15	81-88-9
C.I. Solvent Orange 7	3118-97-6
C.I. Solvent Yellow 14	842-07-9
Cadmium (and its compounds)	
Calcium cyanamide	156-62-7
Carbon disulphide	75-15-0
Carbon tetrachloride	56-23-5
Catechol	120-80-9
Chlorine	7782-50-5
Chlorine dioxide	10049-04-4
Chloroacetic acid (and its salts)	79-11-8
Chlorobenzene	108-90-7
Chloroethane	75-00-3
Chloroform	67-66-3
Chloromethane	74-87-3
Chromium (and its compounds)	
Cobalt (and its compounds)	
Copper (and its compounds)	
Cresol (mixed isomers and their salts)	1319-77-3
Cumene	98-82-8
Cumene hydroperoxide	80-15-9
Cyclohexane	110-82-7
Decabromodiphenyl oxide	1163-19-5
Dibutyl phthalate	84-74-2
Diethanolamine (and its salts)	111-42-2
Diethyl sulphate	64-67-5
Dimethyl phthalate	131-11-3
Dimethyl sulphate	77-78-1
Dinitrotoluene (mixed isomers)	25321-14-6
Epichlorohydrin	106-89-8
Ethyl acrylate	140-88-5
Ethyl benzene	100-41-4
Ethyl chloroformate	541-41-3
Ethylene	74-85-1
Ethylene dibromide	106-93-4

Ethylene glycol	107-21-1
Ethylene oxide	75-21-8
Ethylene thiourea	96-45-7
Formaldehyde	50-00-0
gamma-hexachlorocyclohexane	58-89-9
Hexachlorobenzene	118-74-1
Hexachlorocyclopentadiene	77-47-4
Hexachloroethane	67-72-1
Hydrazine (and its salts)	302-01-2
Hydrochloric acid	7647-01-0
Hydrogen cyanide	74-90-8
Hydrogen fluoride	7664-39-3
Hydrogen sulphide	7783-06-4
Hydroquinone (and its salts)	123-31-9
Isobutyraldehyde	78-84-2
Isopropyl alcohol	67-63-0
Isosafrole	120-58-1
Lead (and its compounds)	
m-Cresol (and its salts)	108-39-4
m-Xylene	108-38-3
Maleic anhydride	108-31-6
Manganese (and its compounds)	
Mercury (and its compounds)	
Methanol	67-56-1
Methyl acrylate	96-33-3
Methyl ethyl ketone	78-93-3
Methyl iodide	74-88-4
Methyl isobutyl ketone	108-10-1
Methyl methacrylate	80-62-6
Methyl tert-butyl ether	1634-04-4
Methylene chloride	75-09-2
Michler's ketone (and its salts)	90-94-8
Molybdenum trioxide	1313-27-5
n,n-Dimethylaniline (and its salts)	121-69-7
n-Butyl alcohol	71-36-3
N-nitroso-di-n-propylamine	621-64-7
N-nitrosodimethylamine	62-75-9
n-Nitrosodiphenylamine	86-30-6
Naphthalene	91-20-3
Nickel (and its compounds)	
Nitric acid	7697-37-2
Nitrilotriacetic acid (and its salts)	139-13-9
Nitrobenzene	98-95-3
Nitroglycerin	55-63-0
o-anisidine	90-04-0
o-Cresol (and its salts)	95-48-7
o-Dichlorobenzene	95-50-1
o-Phenylphenol (and its salts)	90-43-7
o-Xylene	95-47-6
p,p'-Isopropylidenediphenol	80-05-7
p,p'-Methylenebis(2-chloroaniline)	101-14-4
p,p'-Methylenedianiline	101-77-9
p-Cresol (and its salts)	106-44-5

p-Dichlorobenzene	106-46-7
p-Nitrophenol (and its salts)	100-02-7
p-Phenylenediamine (and its salts)	106-50-3
p-Quinone	106-51-4
p-Xylene	106-42-3
PCBs	
Pentachlorophenol	87-86-5
Peracetic acid (and its salts)	79-21-0
Phenanthrene	85-01-8
Phenol	108-95-2
Phosgene	75-44-5
Phosphoric acid	7664-38-2
Phosphorus (yellow or white)	7723-14-0
Phthalic anhydride	85-44-9
Propionaldehyde	123-38-6
Propylene	115-07-1
Propylene oxide	75-56-9
Pyridine (and its salts)	110-86-1
Quinoline	91-22-5
Safrole	94-59-7
sec-Butyl alcohol	78-92-2
Selenium (and its compounds)	
Silver (and its compounds)	
Styrene	100-42-5
Styrene oxide	96-09-3
Sulphuric acid	7664-93-9
tert-Butyl alcohol	75-65-0
Tetrachloroethylene	127-18-4
Tetramethylthiuram disulphide	137-26-8
Thiourea	62-56-6
Thorium dioxide	1314-20-1
Titanium tetrachloride	7550-45-0
Toluene	108-88-3
Toluene-2,4-diisocyanate	584-84-9
Toluene-2,6-diisocyanate	91-08-7
Toluenediisocyanate (mixed isomers)	26471-62-5
Trichloroethylene	79-01-6
Vanadium (fume or dust)	7440-62-2
Vinyl acetate	108-05-4
Vinyl bromide	593-60-2
Vinyl chloride	75-01-4
Vinylidene chloride	75-35-4
Xylene (mixed isomers)	1330-20-7
Zinc (and its compounds)	

APPENDIX C: Chemical list for Indicator 2.

ARET + TRI (by ARET category)

ARET -A1	CAS Number
4,4'-methylenebis(2-chloroaniline)	101-14-4
alpha-hexachlorocyclohexane	319-84-6
gamma-hexachlorocyclohexane	58-89-9
Hexachlorobenzene	118-74-1
PCBs	NA12
Pentachlorophenol	87-86-5
Phenanthrene	85-01-8

ARET A-2	Cas Number
1,4 dichlorobenzene	106-46-7
Cadmium (inhalable & soluble inorganic)	NA1

ARET B-1	CAS Number
2,4,6-trichlorophenol	88-06-2
3,3' dichlorobenzidine	91-94-1
Anthracene	120-12-7
bis(2-ethylhexyl)phthalate	117-81-7
Hexachlorocyclopentadiene	77-47-4

ARET B-2	CAS Number
1,1,2,2-tetrachloroethylene	127-18-4
1,2 dichloroethane	107-06-2
1,4 dioxane	123-91-1
2-naphthylamine	91-59-8
2-nitropropane	79-46-9
4,6 dinitro-o-cresol	534-52-1
alpha-chlorotoluene	100-44-7
Arsenic (inorganic)	NA2
Asbestos	1332-21-4
Beryllium	7440-41-7
bis(2-chloroethyl)ether	111-44-4
Bromodichloromethane	75-27-4
Carbon tetrachloride	56-23-5
Chloroform	67-66-3
Chromium (Cr6+)	NA3
Cobalt (inorganic, soluble)	NA4
Copper (inorganic salts)	NA5
Ethylene oxide	75-21-8
Lead (all forms except alkyl)	NA6
Mercury (elemental and inorganic)	NA7
Methylene chloride	75-09-2
Nickel (inorganic, inhalable, soluble)	NA8
o-anisidine	90-04-0
Silver (soluble inorganic salts)	NA9

Thiourea	62-56-6
Zinc (inorganic, inhalable, soluble)	NA11

ARET B-3	CAS Number
1,1,2-trichloroethylene	79-01-6
1,2-dibromo-3-chloropropane	96-12-8
1,2 diphenylhydrazine	122-66-7
1,3 butadiene	106-99-0
1,3 dichloropropene	542-75-6
2,4-dichlorophenol	120-83-2
2,4 dinitrotoluene	121-14-2
2,6 dimethylphenol	576-26-1
2,6 dinitrotoluene	606-20-2
2-methylpyridine	109-06-8
4-aminoazobenzene	60-09-3
4-aminobiphenyl	92-67-1
4-nitrosomorpholine	59-89-2
Acetaldehyde	75-07-0
Acetamide	60-35-5
Acrolein	107-02-8
Acrylamide	79-06-1
Acrylonitrile	107-13-1
Aniline	62-53-3
Benzene	71-43-2
Benzidine	92-87-5
bis(chloromethyl) ether	542-88-1
Chlorine dioxide	10049-04-4
Epichlorohydrin	106-89-8
Ethylene dibromide	106-93-4
Ethylene thiourea	96-45-7
Formaldehyde	50-00-0
Hydrazine	302-01-2
Hydrogen sulphide	7783-06-4
Methyl isobutyl ketone	108-10-1
N-nitroso-di-n-propylamine	621-64-7
N-nitrosodimethylamine	62-75-9
N-nitrosodiphenylamine	86-30-6
Phenol	108-95-2
Quinoline	91-22-5
Tetramethylthiuram disulphide	137-26-8
Toluene diisocyanates	26471-62-5
Vinyl bromide	593-60-2

APPENDIX D: Participants List

Earl R. Beaver
Director, Waste Elimination
Monsanto
800 N. Bindbergh Blvd.
St-Louis, Missouri 63167
Tel: 314-694-6087
Fax: 314-694-8820

Leonard Surges
Manager, Environment
Noranda Mining and
Exploration Inc.
2700 - 1 Adelaide Street East
Toronto, ON M5C 2Z6
Tel: 416-982-6900
Fax: 416-982-3543

Glenna Ford
GreenWare Environmental Systems
145 King Street East, Suite 200
Toronto, ON M5C 2Y8
Tel: 416-363-5577 (ext: 137)
Fax: 416-367-2653

Timothy Huxley
General Manager
Health, Safety & Environment
Stelco Inc.
Stelco Tower, P.O. Box 2030
Hamilton, ON L8N 3T1
Tel: 905-528-2511 (ext. 4070)
Fax: 905-577-4441

James A. Fava (Facilitator)
Vice President
Strategic Management Services
Roy F. Weston, Inc.
1 Weston Way
West Chester, Pennsylvania 19380-1499
Tel: 610-701-3636
Fax: 610-701-3651

Alan Willis
Environmental Affairs Consultant
The Canadian Institute of Chartered Accountants
277 Wellington Street West
Toronto, ON M5V 3H2
Tel: 416-204-3400 ext 519
Fax: 416-204-3414

Peter Robson
Consultant in Occupational and Environmental Health
35 Roden Street
Kingston, ON K7M 1M6
Tel: 613-549-1284
Fax: 613-549-6249

Amardeep Khosla
Manager, Technical Policy
Procter & Gamble Inc.
4711 Yonge Street
North York, ON M5W 1L5
Tel: 416-730-4391
Fax: 416-730-4449

Stuart Smith (NRTEE Chair)
Chairman
ENSYN Technologies Inc.
C/o 68 King George's Road
Etobicoke, ON M8X 1L9
Tel: 416-232-9671
Fax: 416-232-1594

Yves Ouimet
Director of Environment
Logistics - Corporate Services
Bell Canada 5[e] étage
87, rue Ontario Ouest
Montréal (Quebec) H2X 1Y8
Tel:514-870-8110
Fax: 514-391-8905

Kevin Brady (Facilitator)
Demeter Group
1337b Wellington Street,
Suite 214
Ottawa, Ontario K1Y 3B8
Tel: 819-682-1137
Fax: 819-682-6311

Elizabeth Atkinson
Policy Advisor
1 Nicholas Street, Suite 1500
Ottawa, Ontario
K1N 7B7
Tel: 613-943-0394
Fax: 613- 992-7385

Jean Bélanger (Workshop Chair)
NRTEE Member
2230 Quinton Street
Ottawa, ON K1H 6V3
Tel: 613-731-6362
Fax: 613-731-6199

K.C. Caswell
Team Leader, Eningeering &
Environment
Pacific Northern Gas Limited
1400 - 1185 West Georgia Street
Vancouver, BC V6E 4E6
Tel: 604-691-5674
Fax: 604-691-5863

George Werezak
Dow Chemical Company
Box 1012
1086 Modeland Road
Sarnia, ON N7T 7K7
Tel: 519-339-3131
Fax: 519-339-3513

J. Willie Owens
Principal Scientist, Corporate P&RS
Global LCA Technical Development
Procter & Gamble Company
Ivorydale Technical Canter 5299
Spring Grove Avenue
Cincinnati, Ohio 45217
Tel: 513-627-8183
Fax: 513-627-5526

Markus Lehni
Manager Operations
World Business Council for
Sustainable Development
160, route de Florissant
CH-1231 Conches-Geneva
Switzerland
Tel: 41-22-839-3100
Fax: 41-22-839-3131

Rick Hilton
Manager, Occupational &
Environmental Health
145 King Street West
Suite 1500
Toronto, ON M5H 4B7
Tel: 416-361-7863
Fax: 416-361-7864

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Measuring Eco-efficiency in Business: Developing and Implementing Pollutant Dispersion Indicators

Working Paper for the Feasibility Study Workshop January 26 &27, 1998

Toronto, Canada

Prepared for

National Round Table on the Environment and the Economy

Prepared by

DEMETER GROUP
AND
ROY F. WESTON, INC.

West Chester, Pennsylvania 19380-1499

NRT-1998086

18.00

Preface

The purpose of this document is to provide the overall context, a draft set of indicators, a methodology framework and a plan of action for the development of a pollutant dispersion indicator(s) under the National Round Table on Environment and Economy's Eco-Efficiency Program[1]. The indicators, methodology framework and plan of action are not intended to be prescriptive, but rather to provide a starting point for discussions at the January 26 and 27 workshop. At this workshop volunteer companies will design a feasibility study to test the chosen indicator(s).

The development of toxicity indicators is very complex and scientifically challenging. The indicators proposed in this document are not focused on providing scientific information related to specific cause/effect relationships, exposure pathways, or risks associated with pollutants or toxic substances. The objective of this document, and the National Round Tables's eco-efficiency program, is to develop indicators to support decision-makers in gauging progress toward eco-efficiency. Consequently, the indicators proposed in this document are focused on providing decision-makers with directional information on overall progress in reducing pollutants from their operations, products and services.

It is hoped that companies who participate in the feasibility study to test these indicators will develop cost-effective, credible benchmarks of eco-efficiency. Potentially eco-efficiency indicators can be used for applications such as:

- identification of product and process improvement opportunities;
- benchmarking environmental performance within the company, it's industry sector and against other industries;
- reporting on progress toward sustainability;
- developing informed dialogue with customers, shareholders and investors on environmental performance; and
- providing information to outside stakeholders (e.g. in corporate environmental reports).

Participation in this NRTEE project will give companies an opportunity to develop capacity on the leading edge of environmental performance measurement. If agreed to by the participants, the results of the pilot will be widely promoted, enhancing the company's image as an innovate leader in environmental management

[1] This measure was refered to as a toxic release index in the NRTEE backgrounder publication *Measuring Eco-efficiency in Business.*

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1. BACKGROUND

In the document *Science and Technology for the New Century: A Federal Strategy*, the federal government set out its policy response to the Science and Technology Review. With the aim of achieving sustainable development through innovation, the federal government sought the advice of the National Round Table on the Environment and the Economy (NRTEE) with regard to establishing specific targets to help industries and other sectors become significantly more eco-efficient. They also asked NRTEE to examine the implications of those targets for the development of new technologies. Reaffirming this objective, the Liberal Party in its 1997 plan, *Securing Our Future Together*, stated that the NRTEE would be asked to "expand its work with stakeholders and provincial governments to develop eco-efficiency indicators."

In response, the NRTEE's Eco-efficiency program is developing a system of performance indicators that will assist companies in developing and implementing a set of measurable eco-efficiency indicators.

On April 2, 1997, in Washington, D.C., by invitation of the NRTEE and World Business Council on Sustainable Development (WBCSD), leading representatives from industry, non-government organizations (NGOs) and government met to discuss their experiences in measuring eco-efficiency and to reach conclusions on the feasibility of developing and implementing a core set of eco-efficiency indicators. These individuals came from organizations in Canada, the US, Mexico, Colombia and Switzerland; many had also worked extensively in other countries or were involved in work concerning developing countries; all were practitioners and thinkers in the areas of eco-efficiency, performance measurement and business policy.

The workshop participants agreed that the development and testing of indicators for material and energy intensity held the greatest promise[2]. The workshop participants also discussed the feasibility of developing a toxics release index. They agreed that developing such an index would be problematic due its dependence on value based weighting factors and data limitations. They did, however, agree that relevant indicators for toxic releases could be devised using currently available data. The workshop report concluded that:

> *Development of one or more indicators for toxic dispersion or releases was also considered to be both highly desirable and relatively feasible, since it is likely that toxic release data pertaining to specified substances is already rountinely tracked*

[2] As a first step in testing the feasibility of these indicators the NRTEE held a workshop on November 12-14, 1997, with eight volunteer companies. At the workshop material and energy intensity indicators were designed and subsequently all eight companies have agreed to test the indicators within their organizations.

and recorded by companies under existing domestic laws (in some countries) and international treaties (in many countries).

Detailed discussion on the toxic release index is contained in the NRTEE Backgrounder publication *Measuring Eco-efficiency in Business*. The workshop participants recommended a number of follow-up actions:

- Define the scope of the indicator and reach consensus on the list of specific chemicals (using existing lists and agreed-upon criteria where possible).

- Consider using a phased approach to implementation (e.g. adopt a virtual elimination strategy for certain priority chemicals and measure other chemicals in tonnes per unit of product or service).

- Review existing models/methodologies for measuring toxicity and for reporting toxic emissions.

- Build on existing infrastructure developed for reporting under programs such as the U.S. TRI and Canada's NPRI; consider developing a model to supplement legislated reporting for use a prioritizing tool.

- Conduct field trials.

- Analyze results and engage in further discussion and trials.

As a first step in carrying out these recommendations the NRTEE comissioned a discussion paper entitled *International Performance Indicators for Dispersion of Toxic Chemicals into the Environment*[3]. The paper reviewed possible means to develop pollutant dispersion indicators. It examined current pollutant release and transfer registers and it made the following observations:

- the essential element of a pollutant dispersion indicator is the annual quantity of toxic substances released by an organization per unit of production or business activity;
- the appraoch used by the Canadain Accelerated Reduction/Elimination of Toxics (ARET) program provides the most applicable model for classifying toxic chemical substances;
- although there are models for wieghting or ranking toxicty of chemical substances these schemes are somewhat arbitrary in their allocation of weighting factors; and

[3] G. Peter Robson. *Discussion Paper on International Performance Indicators for Dispersion of Toxic Chemicals into the Environment*. Prepared for the National Round Table on Environment and Economy. October 1997.

- the quality and reliability of quantitative release data can vary, therefore the methodology for calculating releases in a feasibility study will require careful attention.

The main findings of this document have been used to develop the draft pollution dispersion indicators (PDI) put forward in this working paper.

2. EXPECTED WORKSHOP OUTCOMES

At the end of the workshop, participating companies and the NRTEE should be able to reach consensus on:

- the indicators, methodology framework and decision rules the feasibility project will use;
- a communications strategy;
- a schedule and a plan of action; and
- roles and responsibilities of the steering committee, the individual companies, and the NRTEE.

The remainder of this document provides a starting point for achieving these desired workshop outcomes.

3. PURPOSE OF THE FEASIBILITY STUDY

The purpose of the study is to test the feasibility and value of indicators to support the goal of eco-efficiency. Tthe following criteria may be used to establish the PDI:

- Simple to use and understandable by audiences representing broad technical and non-technical backgrounds
- Easy to reproduce from year to year, or company to company
- Complements existing regulatory programs

Further criteria for evaluation include:

- **Robust, non-perverse.** Eco-efficiency indicators must be robust information sources for improvement i.e. clear, scientifically sound, unambiguous, and representative regardless of context. It is an essential corollary that the use of these indicators for decision-making not result in reduced eco-efficiency or increased environmental impacts, elsewhere in the system.

- **Rules for inclusion/exclusion**. Principles, rules and guidance are needed for the transparent inclusion and exclusion of the data, measurements and assumptions used to derive indicators.

- **Data collection cost-effectiveness**. The data and measurements for the indicators should either be available or obtainable in a cost-effective manner.

- **Usefulness as a management tool or a corporate reporting tool**. The indicators should be valuable at several levels within the company, including business unit, regional and corporate level.

Potential audiences for the indicators developed under the feasibility study are:

1. Internal to companies (e.g.,)
   - Business sectors and product development groups
   - Strategic management groups
   - Other company organisations – e.g., environmental quality
   - Employees

2. Potential Co-developers of eco-efficiency indicators where formal liaisons may be useful (e.g.,)
   - World Business Council on Sustainable Development
   - Industrial Pollution Prevention Council
   - Center for Waste Reduction Technologies
   - International Center for Environment Management
   - World Environment Center

3. Stakeholders (e.g.)
   - Customers
   - Financial institutions
   - Competitors
   - Governments
   - Non-governmental organizations (NGOs)

An ultimate goal of the use of eco-efficiency indicators is to establish an accurate, measurable baseline to assist in assessing a company's progress toward certain aspects of eco-efficiency.

4. POTENTIAL INDICATORS

There are a number of regulatory and voluntary programs in existence which help encourage or achieve a reduction in the use of toxic, persistent, and bioaccumulative pollutants. One of the considerations in developing this PDI is not to duplicate existing tools and programs, but to complement them. Our purpose is to provide additional indicators to be used by management to improve performance.

Table 1 provides a classification scheme, developed by Robson, for pollutants. It is based on the Canadian Accelerated Reduction/Elimination of Toxics program (ARET) and it is supplemented with chemicals from the U.S. Toxics Release Inventory (TRI) and the Canadian National Pollutant Release Inventory (NPRI). Within the ARET program there is a weighting scheme which "***groups substances based on*** concerns with toxicity, ***that are linked with*** persistence in the environment and bioaccumulation in living organisms..." This classification scheme is based on criteria (toxicity, bioaccumulation and persistence) that are the recognised by North American industry and government as the primary environmental issues of concern when it comes to the use and release of chemicals.

Table 1: Proposed NRTEE Chemical List

Class	Number of chemicals
Highly Toxic, Bioaccumulative & Persistent (ARET A-1)	30
Highly Toxic & Bioaccumulative & Persistent (ARET A-2)	2
Highly Toxic & Bioaccumulative (ARET B-1)	8
Highly Toxic & Persistent (ARET B-2)	33
Highly Toxic (ARET B-3)	44
Toxic (chemicals common to TRI &NPRI less those on ARET lists)	Approx. 120
Total number of chemicals	Approx. 240

Source: Robson 1997

The Robson paper described the original vision of the toxic release index as "expressed as a single number - the amount of toxic materials released during the manufacture of a product, or during a given operating period, calculated as the sum of the adjusted weights of each toxic material released". The ARET classification system has a simple yet scientifically derived built-in weighting system. It does not, however, provide a weighting factor for each chemical but rather classifies chemicals based on inherent properties. The ARET classification system does not lend itself directly to the development of a single indicator.

The inherent limitations of weighting schemes for toxic chemicals are well known (value based, different environmental endpoints, different cause effect relationships, different inherent properties of chemicals) and developing a single measure based on such a scheme will be problematic and scientifically challenging. Workshop participants must determine:

a) whether a single measure is attainable; or
b) if a different approach based on classes of chemicals, such as those recommended in Table 1, is appropriate.

One trade-off in developing an indicator set based on classes of chemicals is that this approach results in a somewhat larger indicator set. This approach was recognised as a more feasible option than assigning unique toxicity factors to each chemical, at the NRTEE workshop in April. A further advantage of such an approach is that it will be more informative with respect to the internal management of chemicals. A consequence of this type of approach is comparisons between companies will not be easy.

If workshop participants wish to pursue a single measure, developing a weighting scheme for each class of chemicals and rolling these numbers into a single index offers the most promise. Robson suggested a possible weighting scheme for the ARET chemicals. The first indicator set offered below reflects both a single index approach based on a weighting scheme and a disaggregated approach based on classes of chemicals identified in Table 1. The additional proposed indicators, sets 2 and 3, are derived from current company practice and are offered as additional examples to stimulate discussion.

4.1 Indicator Set 1

Option 1:

$$\frac{\text{Mass of chemicals released for each class of the proposed NRTEE Chemical List}}{\text{Unit of Output}}$$

Where chemicals are defined by the NRTEE Chemical List in Table 1. It is suggested that the six classes be used and kept separate (although workshop participants may wish to consider merging ARET A-1 and A-2 chemicals into one class for the purposes of the feasibility study). Unit of output is a measure of the products and co-products[4] that leave the defined manufacturing process, or deliver a defined service A unit of output can be represented as 1) a unit of measurement of output or 2) a unit of revenue. The unit of revenue may be preferred.

[4] "Co-products" are defined as any of two or more products coming from the same manufacturing process and "waste" is defined as any output that is disposed of into the environment. This classification is important for this study because it establishes clear guidance on what is a co-product and what is a waste.

Thus, the minimum PDI will be a set of six (or five) classes of chemicals per unit of output and will be applied at the smallest level of organisation (i.e., manufacturing site)[5]. The number of indicators could be reduced to four if workshop participant agreed that since ARET 1 and 2 substances are, for the most part, targeted for virtual elimination they do not need to tracked.

Option 2

$$\frac{\text{mass of ARET B-1 x Weighting Factor + mass of ARET B-2 x Weighting Factor + mass of ARET B3 x Weighting Factor + mass of Toxics (last class Table 1) x Weighting Factor}}{\text{Unit of Output}}$$

Where the weighting factor used is agreed to by workshop participants and the unit of output is the same as in Option 1.

4.2 Indicator Set 2

Management and Reduction of the NRTEE Chemical List

This type of indicator is a modified version of what is currently being used by TransAlta Corporation, a Canadian energy and electrical utility company. At TransAlta, the indicator is called the **Reduction of Products of Environmental Concern** – where products are ARET ingredients used in construction, operation and maintenance aspects of its business. For the purposes of the feasibility study this would be modified to the proposed NRTEE Chemical List and the indicators, measured against a given baseline year, would be:

- number of substances/chemicals eliminated in each class in Table1;
- number of chemicals used in less quantity in each class in Table 2;
- number of chemicals under review in each class in Table 3; and
- number of chemicals to be reviewed in each class in Table 4.

This indicator set incorporates not only quantitative measures of chemical use but also quantitative indicators of chemical management.

[5] Although in this section, the term manufacturing is used, it should be interpolated as an example of one level of organization that the indicator could be applied. It also can be applied at product, business unit, and/or company basis.

4.3 Indicator Set 3

Chemical Efficiency for the NRTEE Chemical List

This indicator would be measured as:

$$\frac{100\,[\text{total chemical use} - \text{chemical losses}]}{[\text{total chemical use}]}$$

For each reporting period absolute chemical use and chemical losses, for each class, would be tracked along with chemical use efficiency as described above. This type of measure is currently being used by E.B. Eddy a Canadian pulp and paper company.

Note: Depending on the chemicals involved, data availability and internal needs, participating companies may wish to compliment any of the indicators with information on other life cycle stages.

5. METHODOLOGY FRAMEWORK

The following methodological framework is intended as a guide to help facilitate workshop discussions, and to assist in the development of a methodology document. Attempts have been made to ensure that all the major issues have been given placeholders but further issues may arise in the workshop. The overall purpose of the methodology document is to gather in one place, the purpose or goal of the project, its scope, the data collection and handling procedures, data quality expected, decision rules. The methodology will help ensure consistency in the indicator development process and it will provide a point of reference for examination of the results of the pilot.

5.1. Purpose of the Project

The purpose should outline the purpose or intent, the intended audience(s), appropriate applications and limitations. A proposed purpose as been described in section 3 above.

5.2. Scope of the Project

The scope defines the breadth, depth and level of detail of the project. The scope directly influences the costs of developing the indicators and their utility for the intended application. It must be defined up front, and all participants must agree to the scope. The scope should define the indicators and how they will be measured, for example:

- on a facility by facility basis, company wide or per unit of product or service;
- the boundaries (e.g. if by product - will it be over the life cycle or only certain stages of the life cycle such as the ones over which the company has control);
- which methodology for calculating releases will be used.

Once workshop participants have developed these basic areas of agreement, the chosen indicators can be refined. It is important to note that the proposed indicators can be applied at multiple levels within a company (company, business unit, site or product) as illustrated in Figure 1. Participants may chose to apply the indicators at different levels, depending on their particular circumstances and management needs.

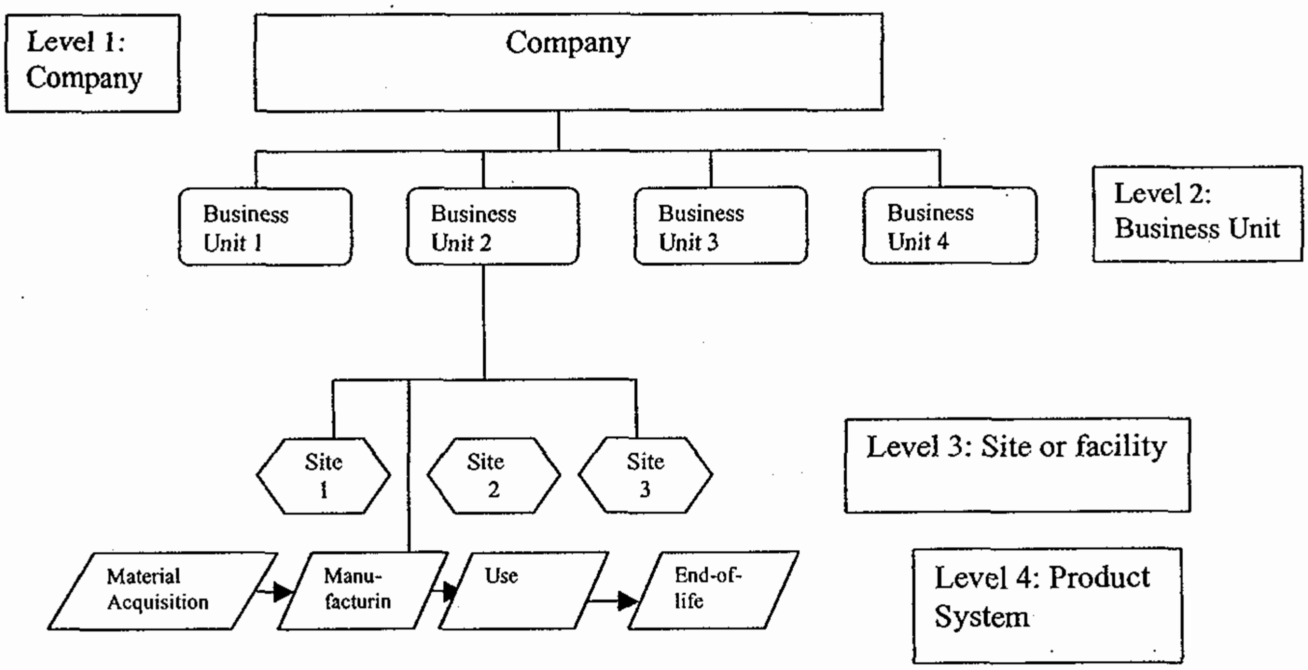

Figure 1: Levels within a company at which indicators can be applied.

5.3. Data collection and calculation procedures

Data collection is the most resource intensive aspect of the project and the procedures that will guide data collection should be clearly mapped - some issues to consider are:

- Allocation procedures - if the indicators are normalised to a product or service how will chemicals be dealt with if multiple products are produced from the same facilities (e.g., different grades of paper from a mill). Various allocation procedures can be used (e.g. on a mass basis or an economic basis).

- Chemical release calculation - how will uncertainty with respect to the quality and reliability of release data be handled
- The use of modelled versus calculated versus estimated data.
- How much data is enough? What are the cut-off rules (95% of chemical use or 99% or something else).

5.4 Data Quality

This section specifies the general data quality requirements needed to meet the project goals. Data quality may be defined as the degree of confidence one has in the data. Every effort should be made by participants to collect high-quality primary data. Where primary data are not available, secondary or surrogate data may be employed.[6]

For each indicator, information regarding the source, nature, and quality of the data shall be reported by the respondent. Where possible, estimates of variability associated with the indicators should be considered and included. Data used in the feasibility study will also be characterised as to whether measured, calculated, or estimated values have been used. These latter indicators are defined as follows:

Measured: Primary data reflect actual measurements (direct sampling) performed during the subject time period.

Calculated: Measured values have been modified to reflect calculations by the process engineer based on process design and operation (report rationale especially where professional judgements and estimates are used).

Estimated: Any secondary data, design-based extrapolations to other facilities or processes or other theoretical calculation (report data source, any allocations, and rationale).

Additionally, qualitative and quantitative data quality indicators (DQIs) may be used. The following section outlines DQIs.

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[6] "Primary" refers to data collected directly from single facilities; "secondary" refers to data acquired from reference materials or published studies. "Surrogate" data may be used where some information is initially missing or ill defined.

5.5 Qualitative Data Quality Indicators

5.5.1 Consistency

Consistency describes how uniformly the methodology is applied not only across different processes and stages within a life cycle, but to other products, systems, and services. Documentation of the assumptions, protocols, and transparency of the process is needed to ensure that the results can be reproduced.

Consistency is assessed by reviewing how tools or procedures (including such things as process flow diagrams, boundary descriptions, templates, normalization and/or aggregation methods, calculations and computer procedures) are applied.

It should be noted that while consistent techniques may be used, diverse results may still be obtained for reasons including the use of different raw materials or different processes. It is easy to misplace or misinterpret the position of process boundaries, which directly affect perceived quality.

5.5.2 Representativeness

Representativeness refers to the degree to which data values and results truly reflect the processes relevant to the indicator included in the study. The degree of representativeness may be judged by comparing data sets for similar processes within the study, and perhaps with sets of published data.

Where published studies are not readily available, an examination of the technological mix of the processes in the study is conducted to ensure that the production-weighted inputs of the various technologies are fairly represented.

5.5.3 Anomalies and Missing Data

Anomalies are extreme data values within a data set. Where a data value is suspect, more information should be obtained, if possible, to determine if the datum is within the expected range of the average value.

Missing data or data gaps are absent data values that are considered important. Where important data are missing, efforts should be made to fill these gaps with measurements or calculations, if possible. Otherwise, explicit and documented estimates may be used to fill the data gaps.

5.6 Quantitative Data Quality Indicators

5.6.1 Completeness

Completeness evaluates the sets of primary data obtained relative to the number of data sets that might possibly be obtained. A measure of the completeness of a primary data category for each manufacturing unit is performed by dividing the number of reporting locations providing data by the number of locations which were solicited for data.

5.6.2 Precision

Precision is a measure of the spread or variability within a data set, expressed as a statistical mean and variance. Where more than three data points exist, a mean and an estimate of variability may be obtained. Such calculations are performed for each primary data category.

6. RESULTS VERIFICATION

Verification of the feasibility study process will be carried out through distribution of the workshop report to the NRTEE Eco-efficiency Task Force and representatives of the stakeholders identified in Section 3.

Although not part of this feasibility study, it is recognized that verification of the procedures used by the companies may be required in the future, as appropriate. Additionally the results of the feasibility study may also be verified by application to other companies prior to full-scale implementation.

7. COMMUNICATIONS PLAN

There are three proposed elements to a communications plan for the project. Ongoing communications of the feasibility project, internal communications between the participants, and communication of the final results.

For ongoing communications, a package will be produced for each participant, which includes:

- A overhead presentation describing the project, indicators, method, expected outcomes and business benefits of participating in the project,
- A one page communication note on the project, including who to contact for additional information, and

- Copy of the report from the January workshop

For internal communications, a schedule for regular information exchange between participating companies will be developed. Whenever possible, electronic forms of communications will be used. When appropriate, follow-up meetings will be scheduled and project updates will be produced.

The third element of the communications plan for this feasibility study will be a strategy (agreed to by all participants) to communicate the final results.

8. OTHER ISSUES FOR CONSIDERATION

8.1 Costs

The feasibility project will endeavor to design the most cost effective approach possible. Participants are encouraged to complement existing measurement and management systems, and capitalize on opportunities to share information and costs. Where possible participants will document costs and business benefits associated with conducting the feasibility study.

8.2 Confidentiality

The federal *Access to Information Act* ("the Act") applies to the NRTEE by virtue of section 24 of the *National Round Table on the Environment and the Economy Act*, S.C. 1993, c. 31 which adds the NRTEE to the list of government institutions subject to the *Access to Information Act*. The *Access to Information Act* provides a right of access to individuals and corporations or other entities in Canada to all records under the control of the NRTEE, subject to the exemptions from disclosure the Act sets out.

Paragraph 20(1)(b) of the Act is a mandatory exemption requiring the government institution to refuse to disclose information which meets the following four criteria:

(1) the information must be financial, commercial, scientific or technical information;

(2) it must be confidential in nature;

(3) the information must be supplied to a government institution by a third party; and

(4) the information must be treated consistently in a confidential manner by the third party.

The NRTEE will take all the measures outlined in the legal opinion obtained for this project to maintain any documentation in a confidential manner. When submitting information for this study, participating companies are asked to clearly mark the material "confidential". However, participants are urged not to communicate information that is confidential to their companies.

9. PLAN OF ACTION

The Steering Committee (SC) is made up from representatives of each of the participating companies, as well as members of the NRTEE Eco-efficiency Task Force. It is essential to have one primary and one or more secondary contacts for each company. This will ensure that participation by the company continues, even when there is a conflict in scheduling interactions among the Steering Committee. It is proposed that the Steering Committee make decisions regarding this project on a consensus basis.

The proposed role of the Steering Committee is to:

- Oversee the implementation of the feasibility study
- Be available to discuss and resolve issues brought up by the individual companies
- Results of individual company efforts are presented to Steering Committee for final agreement and resolution of outstanding issues
- Be available to resolve issues raised by the individual companies
- Direct the preparation of outlines and divide up tasks related to the completion of the feasibility study
- Direct the preparation of the final report

The proposed role of the individual companies is as follows:

- Take the results of the January workshop (indicators, methodology framework and plan of action) and obtain appropriate approval and buy-in from the company
- Be primarily responsible for data collection.
- Participate in the regular information exchange between participating companies and provide representatives to the necessary follow-up meetings
- Be available to describe data collection efforts, and to follow-up and answer questions raised by Steering Committee
- Finalize all data collection efforts
- Assist in preparing draft sections of final report
- Approve final report.

Table 2 sets out the schedule for the feasibility study.

Table 2: Proposed Schedule

Email Word 6.0 version of document + communications piece to NRTEE	Feb. 5
Forward document to participating companies	Feb. 6
Comments from companies back to NRTEE + Go no go decision by companies	Feb. 13
Forward document to potential co-developers – let Them know feasibility study is going forward and check significant concerns	Feb. 13
Response back from potential co-developers	Feb. 27
Initial data collection	Feb.-April
Tele-conference or other communication mechanism to prepare for March session	
Reality Check SC meeting – communication session if appropriate, firm up path forward, liaison with potential co-developers if appropriate	March 17 Globe 98 Vancouver.
Input from companies, outline final report	July 23-24
Draft Final Report	September 15, 1998….
Final Report	December 15, 1998….