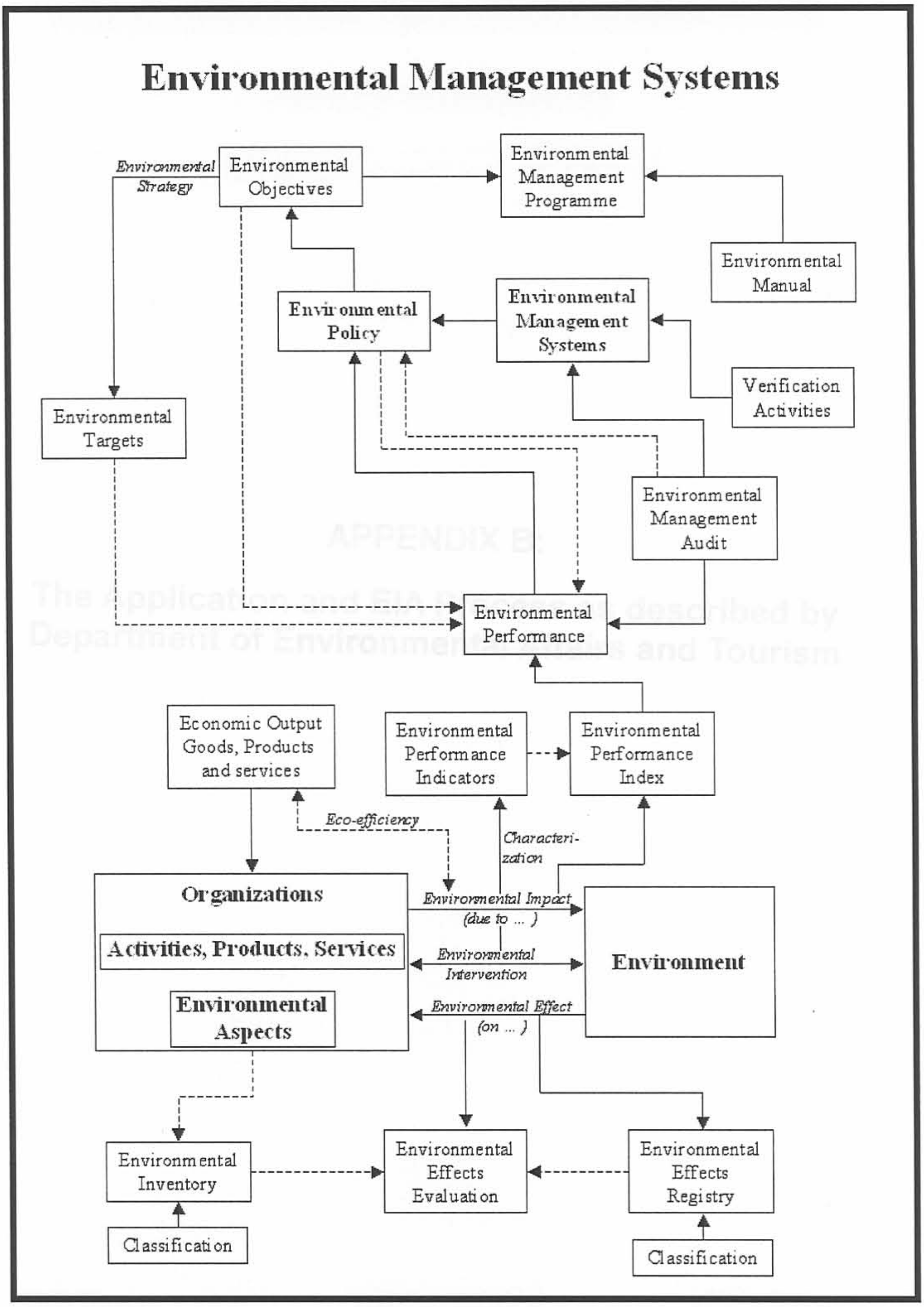
APPENDIX A:

Interaction between EMS, organization and environment

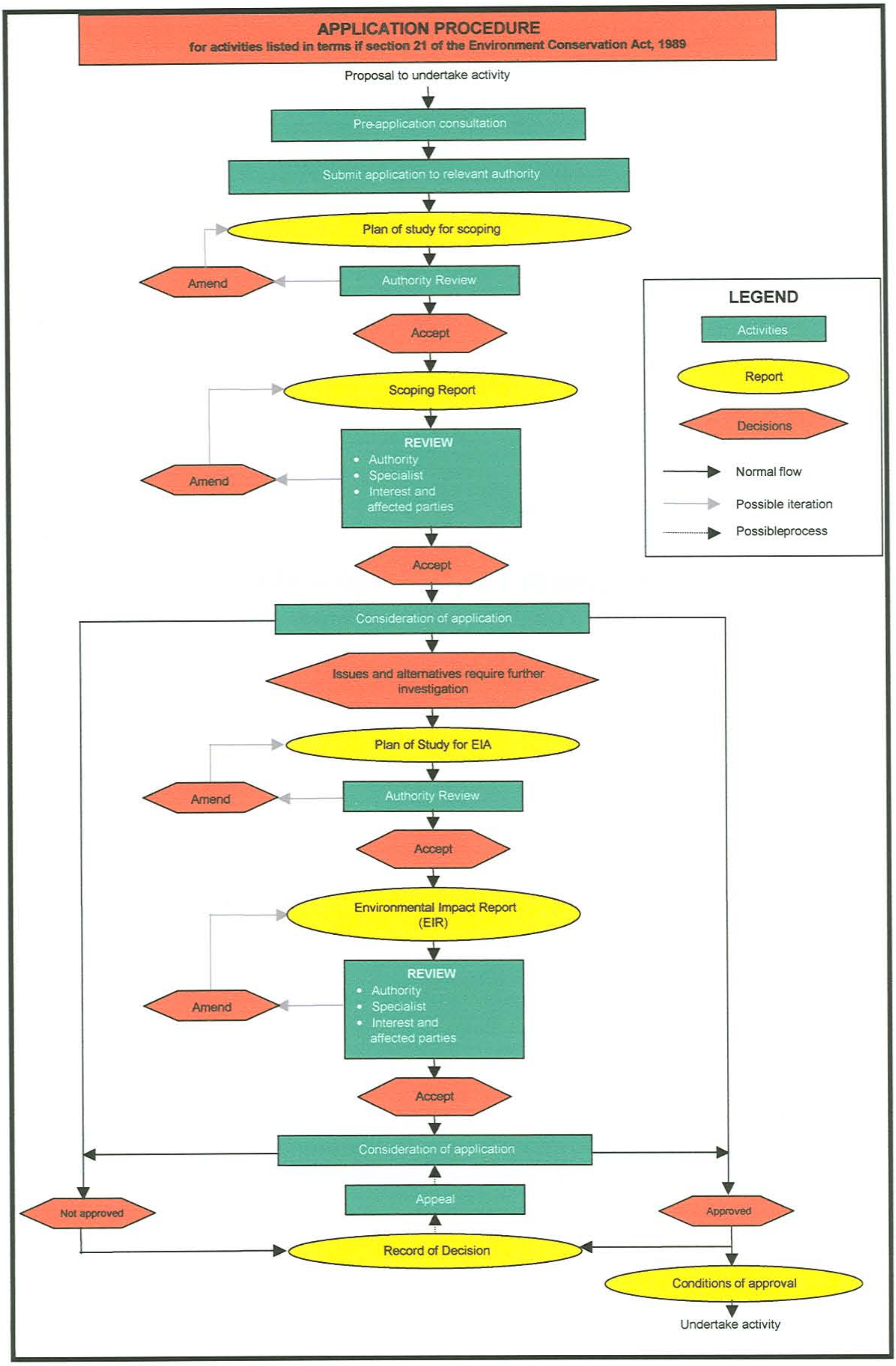


Source: www.gdrc.org/uem/keywords

APPENDIX B:

The Application and EIA Process as described by Department of Environmental Affairs and Tourism

Appendix B: Environmental Impact Assessment Process



Source: DEAT, 1998.

APPENDIX C:

Life Cycle Cost Analysis Methodologies

C 1: LCCA Model of Fabrycky and Blanchard

Fabrycky and Blanchard's LCCA Methodology consist of 10 steps, as shown, in Figure C.1. The superiority of this methodology lies in the detail cost breakdown structure (CBS) it uses. Costs are first divided into one of four categories before it is sub-divided into relevant incremental costs (See Figure C.2). The four main cost categories are:

- Research & Development costs
- Production & Construction costs
- Operation & Maintenance costs
- Retirement & Disposal costs.

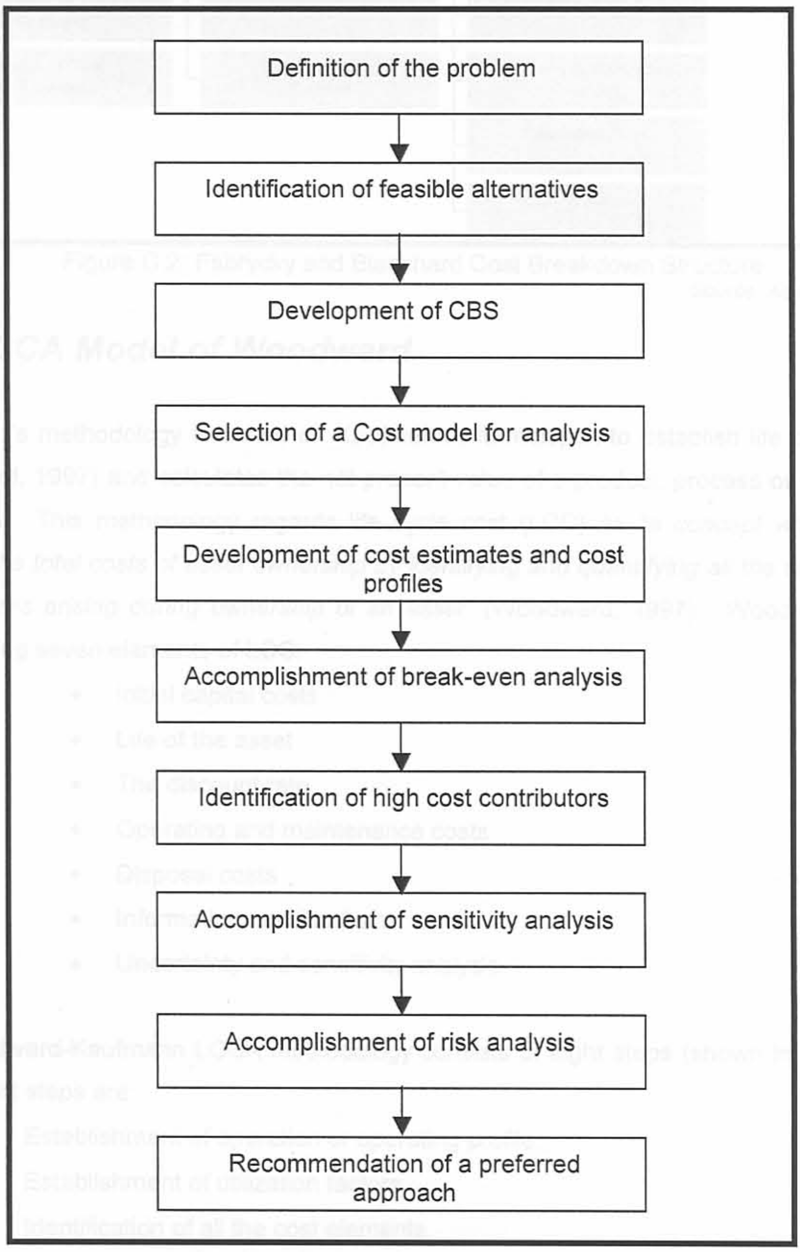


Figure C.2: Fabrycky and Blanchard LCCA Methodology

Source: Durairaj, Ong, Nee & Tan, 2002.

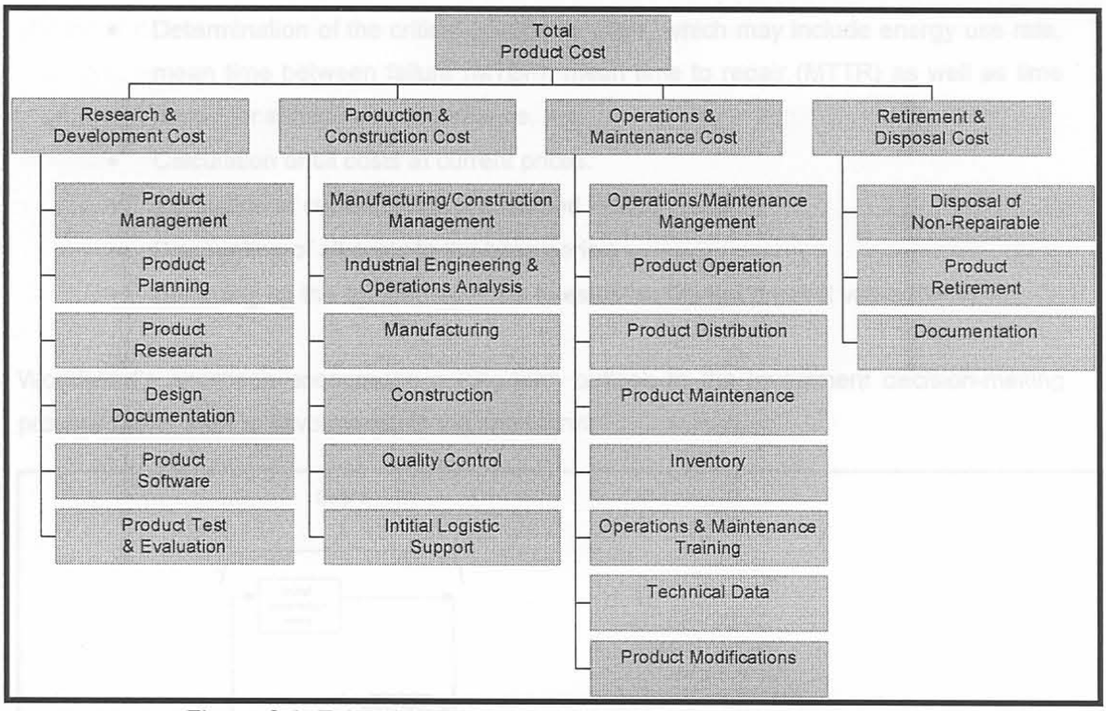


Figure C.2: Fabrycky and Blanchard Cost Breakdown Structure

Source: Asiedu & Gu, 1998

C 2: LCCA Model of Woodward

Woodward's methodology is based on Kaufmann's formulation to establish life cycle costing (Woodward, 1997) and calculates the net present value of a product, process or system's life cycle cost. This methodology regards life cycle cost (LCC) as *"a concept which aims to optimise the total costs of asset ownership by identifying and quantifying all the significant net expenditures arising during ownership of an asset"* (Woodward, 1997). Woodward identify the following seven elements of LCC:

- Initial capital costs
- Life of the asset
- The discount rate
- Operating and maintenance costs
- Disposal costs
- Information and feedback
- Uncertainty and sensitivity analysis

The Woodward-Kaufmann LCCA methodology consists of eight steps (shown in Figure C.3). These eight steps are:

- Establishment of operation or operating profile.
- Establishment of utilization factors.
- Identification of all the cost elements.

- Determination of the critical cost parameters, which may include energy use rate, mean time between failure (MTBF), mean time to repair (MTTR) as well as time period for scheduled maintenance.
- Calculation of all costs at current prices.
- Escalation of current costs at assumed inflation rates.
- Discounting of all costs to the base period.
- Summing up the discounted costs to establish the net present value (NPV).

Woodward's approach encourages a long-term outlook to the investment decision-making process rather than to save money in the short term.

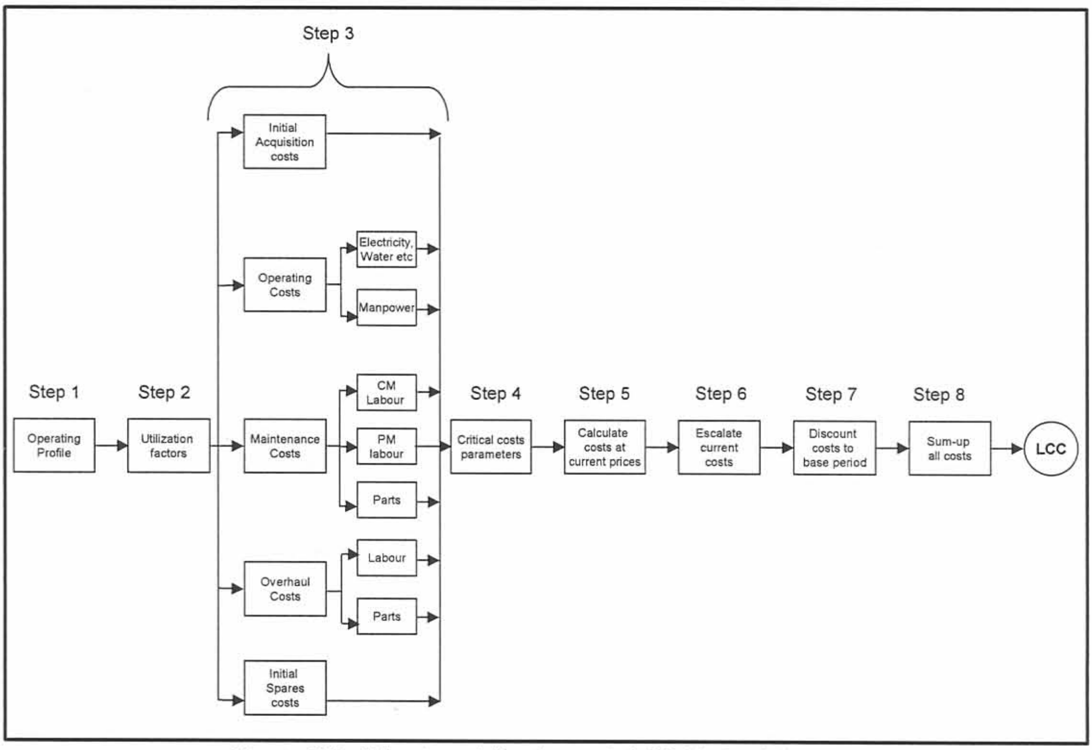


Figure C.3: Woodward-Kaufmann LCCA Methodology

Source: Woodward, 1997.

C 3: LCCA Model of Dahlen and Bolmsjo

Dahlen and Bolmsjo's methodology is often referred to as "Life cycle cost analysis of the labour factor" as it widens the field of application for LCC by focusing on the cost of an employee over the entire employment cycle, i.e. recruitment to retirement. One of parallels between traditional LCC graphs and the costs of an employee "life cycle" is the fact that in both cases the initial cost are high. In the case of the employee this is due to recruitment costs and the costs of training and introducing the employee into the company, while for processes and plants it is the initial construction costs that are high.

Dahlen and Bolsmjo (1996) distinguished between three types of labour cost categories, and also distinguish between sub-costs and elements of sub-costs (see Figure C.4). The inclusion of the labour-related costs in an LCC enables the methodology to assist with industrial decision such as:

- Who is to be employed?
- How much can be invested in education and training of a new employee?
- What is the correlation between costs and the shape of the work tasks and the working environment?
- What should the mix of the production factors capital and labour look like to achieve the most cost-effective production system?

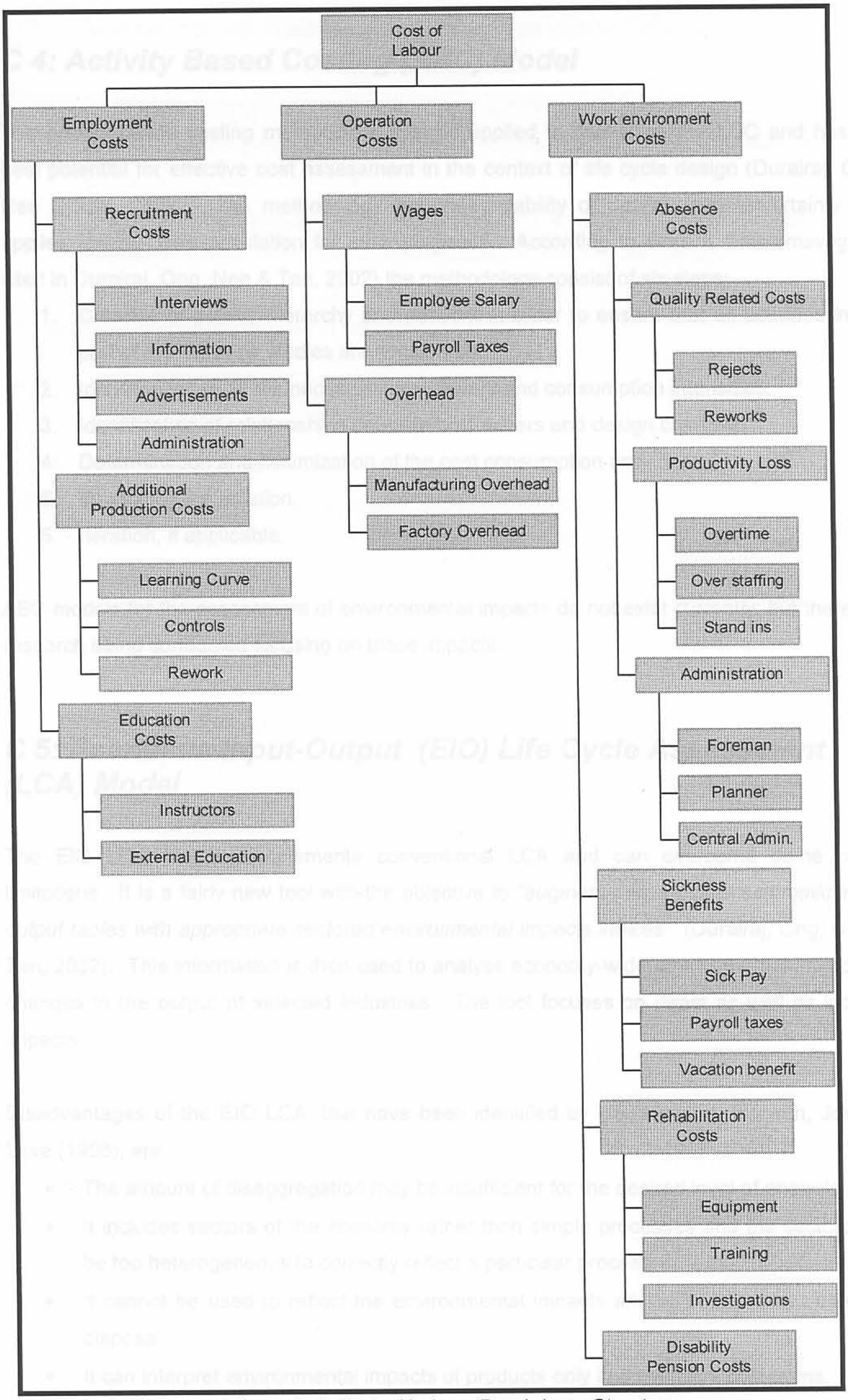


Figure C.4: Cost of Labour Breakdown Structure

Source: Dahlen &Bolsmjo, 1996.

C 4: Activity Based Costing (ABC) Model

The activity based costing methodology can be applied to determine the LCC and has the best potential for effective cost assessment in the context of life cycle design (Durairaj, Ong, Nee & Tan, 2002). The methodology has the capability of dealing with uncertainty and applies Monte Carlo simulation for such purposes. According to Bras & Emblemsvag (as cited in Durairaj, Ong, Nee & Tan, 2002) the methodology consist of six steps:

1. Creation of activity hierarchy and network in order to ensure that all activities in the part of the life cycle studies are considered.
2. Identification of all the necessary cost drivers and consumption intensities.
3. Identification of relationships between cost drivers and design changes.
4. Determination and minimization of the cost consumption activities.
5. Evaluating the solution.
6. Iteration, if applicable.

ABC models for the assessment of environmental impacts do not exist currently; but there are research being conducted focusing on these impacts.

C 5: Economic Input-Output (EIO) Life Cycle Assessment (LCA) Model

The EIO LCA Model complements conventional LCA and can overcome some of its limitations. It is a fairly new tool with the objective to *"augment conventional economic input-output tables with appropriate sectored environmental impacts indices"* (Durairaj, Ong, Nee & Tan, 2002). This information is then used to analyse economy-wide environmental impacts of changes in the output of selected industries. The tool focuses on direct as well as indirect impacts.

Disadvantages of the EIO LCA, that have been identified by Hendrickson, Horvath, Joshi & Lave (1998), are:

- The amount of disaggregation may be insufficient for the desired level of analysis.
- It includes sectors of the economy rather than simple processes and the sectors can be too heterogeneous to correctly reflect a particular process.
- It cannot be used to reflect the environmental impacts arising from product use and disposal.
- It can interpret environmental impacts of products only in cumulative cost terms.

Advantages of the EIO LCA Model have also been identified by Hendrickson, Horvath, Joshi & Lave (1998) as well as Durairaj, Ong, Nee & Tan (2002). These advantages include:

- Analysts do not need to draw arbitrary boundaries due to the fact that a comprehensive model of the economy is used.
- Analyses can be performed rapidly and inexpensively.
- Analyses are transparent due to the fact that only publicly available data and standard calculations are used.
- The sector model includes effects attributable to the influences of many indirect suppliers. These effects are often overlooked in the process models.

Online EIO LCA data is available at: http://www.eiolca.net

C 6: Design to Cost (DTC) Model

The DTC model is an attempt to combine cost modelling with Quality Function Deployment (QFD). The methodology can be applied in the design phase of products as it aims to assess the potential trade-offs between costs and performance of competing product alternatives. The application of the model is therefore limited to early stages of production system design (Durairaj, Ong, Nee & Tan, 2002). The DTC model consists of a procedure to select a system design, and has three main functions:

- Derivation of system performance
- Evaluation of system costs
- Presentation of results and decision-making.

Design to Cost differs from Design for Cost, since Design to Cost obtains a design satisfying the functional requirements for a given cost target while Design for Cost is the "*conscious use of engineering process technology to reduce life cycle cost*" (Asiedu & Gu, 1998).

C 7: Product Life Cycle Cost Analysis (PLCCA) Model

The aim of this methodology is to calculate the life cycle costs of capital goods like machines and it focus on single processes connected to a product's life cycle. Durairaj, Ong, Nee & Tan (2002) states that the model can achieve cost reduction in the different life cycle phases through *"a product conception directed towards the needs of the use phase"*. Atling (1993, as cited in Asiedu & Gu, 1998) identified the following costs in the different life cycle phases of a product (Table C.1):

	Company Cost	Users Cost	Society Cost
Design	• Market Recognition • Development		
Production	• Materials • Energy • Facilities • Wages, Salaries, etc		• Waste • Pollution • Health Damages
Usage	• Transportation • Storage • Waste • Breakage • Warranty Service	• Transportation • Storage • Energy • Materials • Maintenance	• Packaging • Waste • Pollution • Health Damages
Disposal/Recycling		• Disposal/Recycling Dues	• Waste • Disposal • Pollution • Health Damages

Table C.1: Product Life Cycle Stages and Costs

Source: Asiedu & Gu, 1998.

Asiedu and Gu (1998) proposes that various techniques must be used to calculate all cost elements in every phase, the bottom line is that the cost over the entire life-cycle must be calculated for the company, users and society.

C 8: Total Cost Assessment (TCA) Model

The American Institute of Chemical Engineers' (AIChE) Centre for Waste Reduction Technologies (CWRT) has conducted various research projects about the concept of Total Cost Assessment. These efforts have culminated in the publication of a TCA Methodology Manual in 1999 and a fully automated TCA tool called TCAce™. The CWRT markets TCA as an "Internal Managerial Decision Making Tool". Beaver (2000) regards total cost assessment as *"a dynamic and emerging concept that seeks to quantify all impacts and costs associated with a decision"*.

The TCA Methodology distinguishes between five types of costs (see Table C.2).

Cost Type	Definition
Type 1: Direct costs for the manufacturing site	Direct costs of capital investment, labor, raw material and waste disposal. Includes both recurring and non-recurring costs as well as both capital and operations and management (O&M) costs.
Type 2: Potentially hidden corporate and manufacturing	Indirect costs not allocated to the product process. May include both recurring and non-recurring costs. Includes

site overhead costs	capital and O&M costs as well as outsourced services.
Type 3: Future and contingent liability costs	Liability costs include fines and penalties caused by non-compliance and future liabilities for forced clean-up, personal injury and property damage.
Type 4: Internal intangible costs	Costs paid by the company and includes difficult to measure cost entities such as worker wellness, worker morale, customer loyalty, corporate image, estimates of avoided costs, etc.
Type 5: External costs	Costs for which the company does not pay (see definition of externalities in Glossary).

Table C.2: Costs included in TCA Methodology

Source: AIChE CWRT, 1999.

The TCA Methodology consist of the following seven steps:

1. Project Definition & Scoping
2. Streamline the Analysis
3. Identify Potential Risks
4. Conduct Total Cost Inventory
5. Conduct Impact Assessment
6. Document Results
7. Feedback to the Company's Main Decision Loop

Gloria & Norris (2002) states that TCA is an aid to internal decision making due to the following properties (regarded by some as benefits) of the methodology:

- TCA captures direct and indirect costs
- TCA quantifies contingent and future liabilities
- TCA identifies intangible costs and costs of externalities and incorporate these costs in a semi-quantitative but transparent approach
- TCA is scalable and can therefore be applied to all sized of companies
- TCA is specific to location (RSA, US, Europe, etc)
- TCA is credible to internal stakeholders
- TCA allows the temporal nature of the costs to be considered
- TCA can be applied from process-specific to plant level

The CWRT's TCA Project team did undertake various case studies and pilot projects for integrating TCA into an existing corporate structure. The results were very favourable (Gloria & Norris, 2002).

C 9: Life Cycle Environment Cost Analysis (LCECA) Model

The LCECA Methodology focus on products but the ideas are more generic applicable. It aims to include eco-costs into the total costs of the products and defines eco-costs as all direct and indirect costs resulting from environmental impacts caused by the product over its entire life cycle (Kumaran, Ong, Tan & Nee, 2001). The methodology consists of nine steps and the methodological framework can be seen in Figure C.5.

The model introduces a new generic cost breakdown structure for eco-costs (see Figure C.6). The methodology then uses linear regression techniques to find the relationship between eco-costs and total costs.

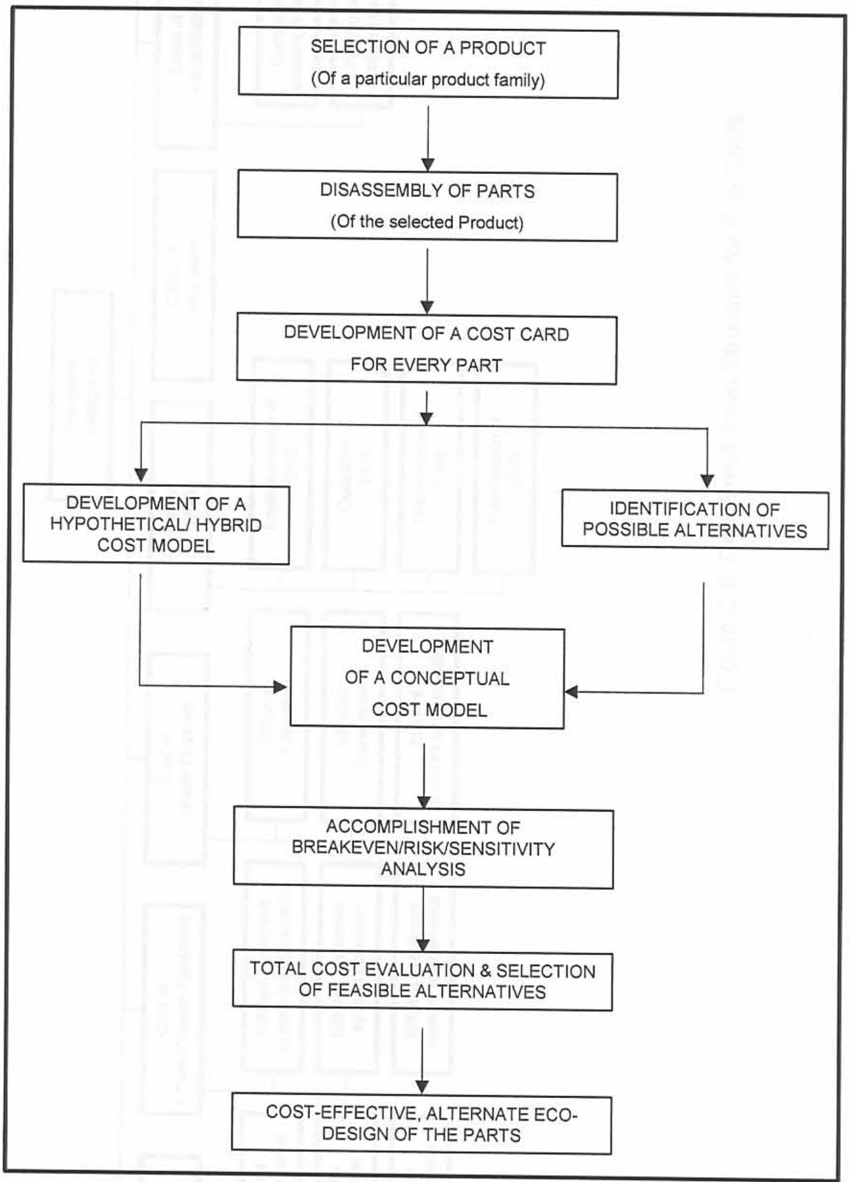


Figure C.5: The methodological framework for LCECA Model

Source: Kumaran, Ong, Tan & Nee, 2001

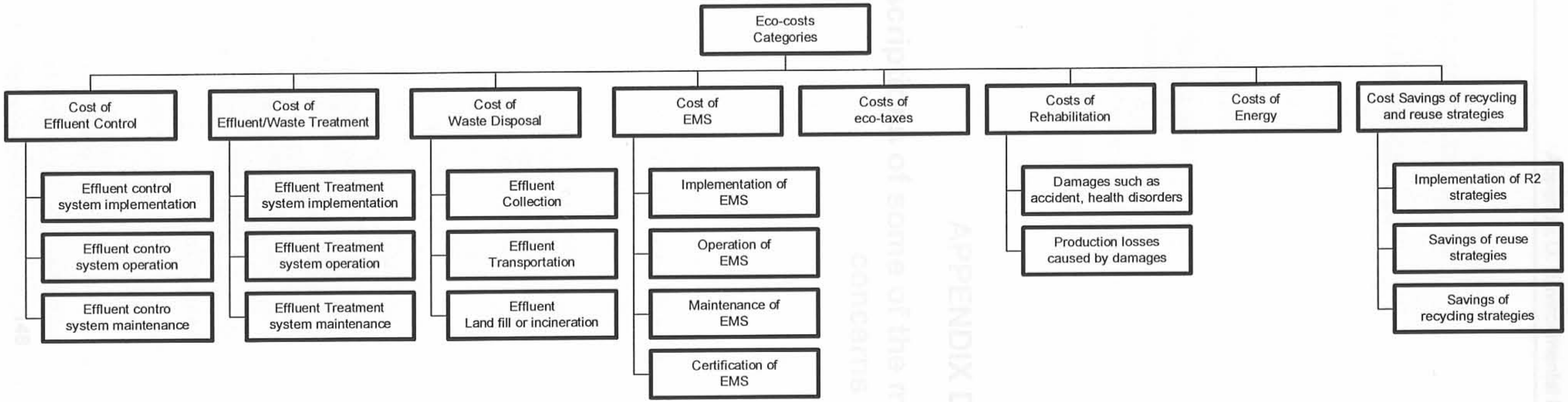


Figure C.6: Cost Breakdown Structure for Eco-Costs

Source: Kumaran, Ong, Tan & Nee, 2001

APPENDIX D:
Descriptions of some of the major environmental concerns

D.1 Global Scale Concerns

D.1.1 Global Climate Change

Climate can be defined as *"the patterns of common meteorological conditions (temperature, precipitation, winds, etc) over long time periods"* (Graedel & Allenby, 1995). According to the United States' Environmental Protection Agency (EPA) the global temperature has risen 0.45-0.6°C over the last century, precipitation has increased by about 1 percent over the world's continents and the sea level has risen with approximately 15-20 cm. Although climate has changed considerably over centuries or millennia through earth's history there is new and stronger evidence that most of the warming over the last 50 years is attributable to human activities (US EPA Global Warming Website).

"Energy from the sun drives the earth's weather and climate, and heats the earth's surface; in turn, the earth radiates energy back into space. Atmospheric greenhouse gases (water vapour, carbon dioxide, and other gases) trap some of the outgoing energy, retaining heat somewhat like the glass panels of a greenhouse. Without this natural "greenhouse effect," temperatures would be much lower than they are now, and life as known today would not be possible. However, problems may arise when the atmospheric concentration of greenhouse gases increases" (US EPA Global Warming Website). The greenhouse effect is shown in Figure D.1.

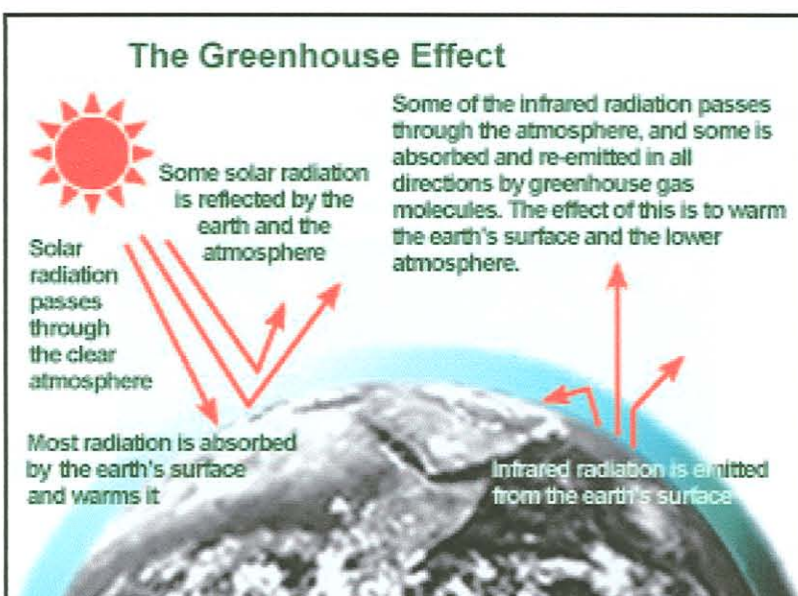


Figure D.1: Greenhouse Effect

Source: EPA Global Warming Website, http://www.epa.gov/globalwarming/climate/index.html

Certain greenhouse gases occur naturally in the atmosphere but the concentration thereof is increased by human activity, e.g. CO_2, whilst other greenhouse gases are the result of human activity e.g. chlorofluorocarbons (CFC). The concept of a Global Warming Potential (GWP) has been introduced to compare the ability of each greenhouse gas to trap heat in the atmosphere relative to another gas (Guinée, 2001). Carbon dioxide (CO_2) was chosen as the reference gas to calculate a GWP.

D.1.2 Ozone Depletion

The ozone layer (found in the stratosphere) is of extreme importance for human health and ecosystem quality as it prevents a portion of the radiation from the sun to reach earth's surface by absorbing it. The importance of this also lies in the fact that ozone absorbs the harmful portion of ultraviolet light called UVB. The EPA believes that *"less protection from ultraviolet light will, over time, lead to higher skin cancer and cataract rates and crop damage"*.

A research group of the British Antarctic Survey (BAS) noticed a dramatic loss in ozone in the lower stratosphere over Antartica in the 1970's. Measurements taken in 1985 confirmed that the total amount of ozone in the stratosphere over Antartica has rapidly decreased (Cambridge University, 2002).

In the United Nations Environment Program's Scientific Assessment of Ozone Depletion (1994) it was confirmed "*that the observed middle-and high-latitude ozone losses are largely due to anthropogenic causes*"(as cited on Greenpeace Website). It is widely accepted that it is chlorine and bromine compounds in the atmosphere that causes ozone depletion.

Chlorofluorocarbon (CFC) was thought of as a miracle gas until it was realized that it is a ozone-depletion substance. The ozone depletion process in Figure 4.3 focuses on CFCs, but the basic concepts apply to all of the ozone-depleting substances.

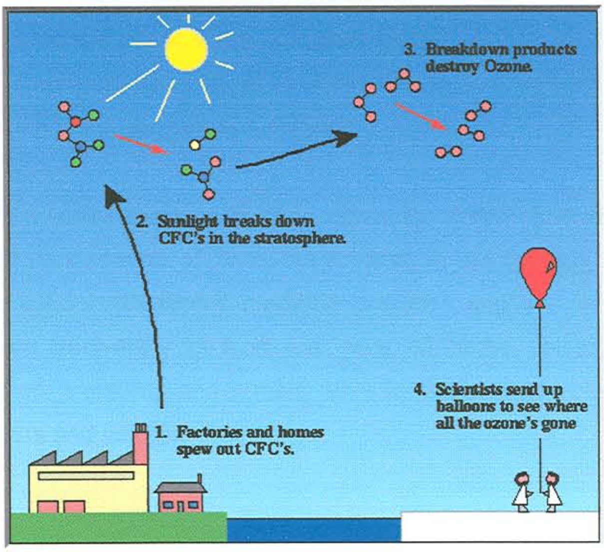


Figure D.2: Ozone Depletion Process

Source: http://www.atm.ch.cam.ac.uk/tour/part3.html

As for greenhouse gases an ozone depletion potential (ODP) has been introduced to compare ozone depletion substances, and CFC-11 is most commonly used as the reference gas to calculate equivalent factors (Guinée, 2001).

D.1.3 Reductions in Biodiversity

The World Resource Institute (WRI) define biological diversity or biodiversity as *"the variety of the world's organisms, including their genetic diversity and the assemblages they form"* while ENCARTA defines biodiversity as *"the range of organisms present in a given ecological community or system."*

Graedel & Allenby (1995) believe that there is general agreement among ecologists that the extinction of species of fauna and flora are rapidly increasing and that it could constitute a global extinction event. Figures for documented extinctions of species are most probably an underestimate for the following reasons:

- Species are generally not declared to be extinct until years after they have last been seen.
- The vast majority of species has not yet even been described, and many may disappear before they are even known to science (WRI)

According to the WRI 700 worldwide extinctions of vertebrates, invertebrates, and vascular plants have been recorded since 1600 and it is unknown how many species went extinct without anybody realising it. WWF believes that currently 34,000 plant species, or 12.5 per cent of the world's flora, are under threat of extinction. The WRI has identified 6 main mechanisms that causes a loss of biodiversity:

- Habitat loss and fragmentation
- Introduced species
- Over-exploitation of plant and animal species
- Pollution of soil, water, and atmosphere
- Global climate change
- Industrial agriculture and forestry

The reduction in biodiversity poses a threat to humanity. WWF has estimated that around 25,000 to 30,000 different species of plants are currently in use by man, while around 25,000 have or are being used in traditional medicine practices and that is only in the tropics. Humanity depends on biodiversity for food, fuel, fibre, oil, herbs, spices, medicines, building material, livestock feed, protection and in many ways for the aesthetic pleasure they can bring in their shapes, colours and smells.

D.2 Regional Scale Concerns

D.2.1 Surface Water Chemistry Changes

The effects of human activities can directly alter surface water chemistry e.g. the discharging of industrial residue streams into water or indirectly through atmospheric transportation and deposition of anthropogenic emissions. The result of the alteration in the chemistry of surface water causes highly publicized environmental problems such as:

- Acidification, whereby the concentration of free hydrogen ions increase in the ambient water resources.
- Euthropication, which is the process by which water becomes rich in dissolved nutrients, these circumstances then encourage the growth and decomposition of oxygen-depleting plant life that results in a lack of oxygen for other organisms living in the water.
- Pollution of water resource by toxic metals and organics

D.2.2 Soil Degradation

Soil degradation refers to the rate at which land is rendered unusable for agricultural activity. The land loss is due to soil erosion, poor water management, which leads to subsequent soil erosion and certain agricultural practices. The WRI estimates that an additional 5 million to 6 million hectares are lost to severe soil degradation annually. Soil degradation contributes in the decline in global food supply. Pierre Crosson (1994) (as cited on WRI website) estimated that soil degradation between 1945 and 1990 lowered world food production with 17 percent.

D.2.3 Precipitation Acidity

Precipitation acidity or acid rain as it is commonly known has been a topic of intense investigation in the 1980's. Precipitation acidity is caused by the presence of CO_2 and natural and anthropogenic nitrogen and sulphur species that increase the acidity of clouds and precipitation (Guinée,2001). The change in acidity effects water, land as well as species living in water and land.

D.2.4 Visibility

Graedel & Allenby (1995) defines visibility as *"the greatest distance over which one can see and identify familiar objects with the unaided eye"*. Visibility involves two factors:

- Degree to which light coming from the object is absorbed or scattered
- Visual threshold of perception

The first factor can however be influenced by anthropogenic activities. Graedel & Allenby (1995) state that the two principle causes of decreased visibility are:

- emission of small particles (0.2-0.7 μ) to the atmosphere
- emission of reactive gases that are subsequently converted to small particles

D.2.5 Herbicides and Pesticides

Herbicides and pesticides are an environmental concern mainly due to the fact that it is designed to be biological damaging. It is known that the chemicals in herbicides and pesticides influence and effects water, air as well as land resources. Graedel and Allenby (1995) believe that the level of concern is a function of: toxicity of product, longevity, method of application as well as intensity of application. Within Africa, the use of DDT for malaria purposes is one of the primary environmental concerns in this respect, and the application thereof is finely controlled (Department of Health Website).

D.3 Local Scale Concerns

D.3.1 Smog

The term 'smog' was first used during the 1950s to describe a mixture of smoke and fog experienced in London (Australian Environmental Protection Agency Website). Smog is of environmental concern as it influences visibility and can cause damage to vegetation and human health. It is possible to distinguish between "winter" and "summer" smog.

Summer smog is also known as photochemical ozone creation and refers to the production of ozone in the troposphere, i.e. at groundlevel. This is mainly due to the different nitrogen oxides being released into air. The pollutants in the air then undergo chemical reaction due to the sunlight and create harmful secondary pollutants such as ozone and peroxyacylnitrate (PAN). Photochemical smog is also often referred to as "brown-air smog".

Winter smog is also known as sulphurous smog, sometimes called gray-air smog. Particulates from factories and sulphur oxides are the primary cause of sulphurous smog. The Great London Smog experienced in 1952 is an example of winter smog.

D.3.2 Groundwater Pollution

The quality of groundwater has become an environmental concern lately, as high quality groundwater is essential to the health and welfare of a large fraction of the earth's population (Graedel & Allenby, 1995). Groundwater are polluted or contaminated by: sewage disposal, agricultural activities, solid-residue disposal in landfills, disposal of liquid residue, petroleum leakages, pesticides and other chemicals. The pollution of groundwater is starting to become a major environmental problem.

D.3.3 Toxics in Sludge

Sludge refers to a moist solid mass that is the product of treated wastewater. Sludge can contain undesirable anthropogenic pollutants and various disposal options have been investigated such as landfilling, land application as fertilizer and even ocean dumping (which is now illegal). The presence of toxics in sludge is therefor an environmental concern as the disposal thereof can lead to impacts on land, water and even air resources.

D.3.4 Oil Spills

Oil spills are usually major news events due to the photogenic properties of such an occurrence. Although experts regard it as a more moderate risk to the environment due to the fact that spoiled oil loses toxicity (Graedel & Allenby, 1995). It remains an environmental concern as it does have a local or even regional environmental impact.

D.3.5 Hazardous Waste Sites

Hazardous Waste sites are locations where toxic materials and waste are confined. These sites are of environmental concern as the emissions contained in the material still have the potential to cause significant harm. It is for that reason that active as well as inactive sites are monitored. Special attention must be given to older inactive sites, as often no liners or ineffective liners were used in these landfills and leachates to groundwater reserves could be problematic.

APPENDIX E:
Sustainable Development Indicators

E.1: United Nations: Sustainable Development Theme Indicator Framework

Theme	Sub-theme	Indicator
SOCIAL		
Equity	Poverty (3)	Percent of Population Living below Poverty Line
		Gini Index of Income Inequality
		Unemployment Rate
	Gender Equality (24)	Ratio of Average Female Wage to Male Wage
Health (6)	Nutritional Status	Nutritional Status of Children
	Mortality	Mortality Rate under 5 years old
		Life Expectancy at Birth
	Sanitation	Percent of Population with Adequate Sewage Disposal Facilities
	Drinking Water	Population with access to safe drinking water
	Healthcare Delivery	Percent of Population with access to primary health care facilities
		Immunization against infectious childhood diseases
		Contraceptive Prevalence Rate
Education (36)	Education Level	Children reaching Grade 5 of Primary Education
		Adult Secondary Education Achievement level
	Literacy	Adult Literacy Rate
Housing (7)	Living Conditions	Floor Area per person
Security	Crime (36.24)	Number of recorded crimes per 100.000 Population
Population (5)	Population Change	Population Growth Rate
		Population of Urban Formal and Informal Settlements
ENVIRONMENTAL		
Atmosphere (9)	Climate Change	Emissions of Greenhouse Gas
	Ozone Layer Depletion	Consumption of Ozone Depleting Substances
	Air Quality	Ambient Concentration of Air Pollutants in Urban Areas
	Agriculture (14)	Arable and Permanent Crop Land Area
		Use of Fertilizers

Land (10)		Use of Agricultural Pesticides
	Forests (11)	Forest Area as a percent of Land Area
		Wood Harvesting Intensity
	Desertification (12)	Land affected by desertification
	Urbanization (7)	Area of Urban Formal and Informal Settlements
Oceans, Sea and Coasts (17)	Coastal Zone	Algae Concentration in Coastal Waters
		Percent of Total Population Living in Coastal Areas
	Fisheries	Annual Catch by Major Species
Fresh Water (18)	Water Quantity	Annual Withdrawal of Ground and Surface Water as a percent of Total Available Water
	Water Quality	BOD in Water Bodies
		Concentration of Faecal Coliform in Freshwater
Biodiversity (15)	Ecosystem	Area of selected key ecosystems
		Protected area as a percentage of total area
	Species	Abundance of selected key species
ECONOMIC		
Economic Structure (2)	Economic Performance	GDP per Capita
		Investment Share in GDP
	Trade	Balance of Trade in Goods and Services
	Financial Status (33)	Debt to GNP Ratio
		Total ODA Given or Received as a Percent of GNP
Consumption and Production Patterns (4)	Material Consumption	Intensity of Material Use
	Energy Use	Annual Energy Consumption per Capita
		Share of Consumption of Renewable Energy Resources
		Intensity of Energy Use
	Waste Generation and Management (19-22)	Generation of Industrial and Municipal Solid Waste
		Generation of Hazardous Waste
		Generation of Radioactive Waste
		Waste Recycling and Reuse
	Transportation	Distance travel per capita by mode of transport
INSTITUTIONAL		

Institutional Framework (38.39)	Strategic Implementation of SD (8)	National Sustainable Development Strategy
	International Cooperation	Implementation of Ratified Global Agreements
Institutional Capacity (37)	Information Access (40)	Number of Internet subscribers per 1000 Inhabitants
	Communication Infrastructure (40)	Main Telephone lines per 1000 Inhabitants
	Science & Technology (35)	Expenditure on Research and Development as a percent of GDP
	Disaster Preparedness and Response	Economic and Human Loss due to Natural Disaster

*Numbers in brackets indicate relevant Agenda 21 chapters.

Table 2: Indicator Theme Framework

Source: UN: Indicators of Sustainable Development: Guidelines and Methodologies

E.2: South Africa: Environmental Indicators for National State of the Environment Reporting

Atmosphere & Climate	
Climate Change	• Greenhouse gas emissions • Energy Use • Size of the national net carbon sink • Malaria: morbidity and mortality • Mean annual temperature • Cost of carbon abatement • Cost of natural disaster relief • Energy intensity
Stratospheric Ozone	• Consumption of ozone depleting substances • UV-B trends • Stratospheric ozone level
Air Quality	• Ambient sulphur dioxide concentration • Ambient nitrogen dioxide concentration
Biodiversity and Natural Heritage	
Species diversity	• Threatened and extinct species per taxonomic group • Endemic species per taxonomic group • Alien (non-indigenous) species per taxonomic group • Population trends for selected species • Distribution and abundance of selected alien species
Habitat Change	• Extent of conserved areas • Extent of natural areas remaining • Disturbance regimes: fire frequency • Disturbance regimes: flood and drought
Resource Value	• Contribution to job creation: conservation areas • Contribution to job creation: eradication of alien species

	• Economic contribution of commercially utilised indigenous species • Economic contribution of commercially utilised freshwater species • Economic contribution of commercially utilised marine, coastal and estuarine species • Economic contribution of commercially utilised terrestrial species
Natural Heritage Resources	• Status of natural heritage resources • Investment into natural heritage resources • Visitors to natural heritage resources
Environmental Management	
Environmental Management	• Multi-lateral environmental agreements • Budgetary allocation to natural resource management • Budgetary allocation to environmental education • Budgetary allocation to environmental research • Inclusion of Integrated Environmental Management (IEM) into IDPs and SDIs • Conciliation Cases • Voluntary adoption of environmental management systems • Voluntary use of environmental accounting and reporting • Government capacity for environmental management • Environmental reporting by government departments
Human Well-Being	
Human Settlements	• Green space per settlement • Contaminated land per settlement • Housing density • Urban/rural population • Proportion of urban area in South Africa
Vulnerability	• GDP/capita • Life expectancy • Adult literacy rate • Employment rate • Population growth rate • HIV/AIDS incidence • Household energy use • Access to water • Access to sanitation
Land Use	
Land Use	• Land cover • Land productivity versus potential
Land Condition	• Desertification • Soil loss • Soil acidification • Soil salinisation • Land degradation • Persistent organic pollutants
Marine, Coastal and Estuarine Environments	
Resource Management	• Catches and Maximum Sustainable Yield per fishery sector • Distribution and abundance of resource species • Catch per unit effort per fishery sector

	• Commercial fishing rights supporting SMME development
Resource Quality	• Estuarine Health Index (State of South African Estuaries) • Pollutant lading entering the seas from land based sources • Blue Flag beaches • Concentrations of heavy metals in sediments or biological tissues • Oil pollution accidents along the coast • Land cover change in coastal zone • Population density change in the coastal zone
Waste Management	
Waste generation	• General waste produced per income group per year • General waste produced per capita per year • Hazardous waste produced per sector per year
Waste reduction	• Waste recycling • Value of waste recycled • General waste correctly disposed through landfill • Hazardous waste correctly disposed • Available landfill lifespan • Provincial expenditure on waste management • Provincial waste collection capacity
Inland Water	
Water Quantity	• Intensity of use of surface water resources • Intensity of use of ground water resources • Total surface water used per sector • Total ground water used per sector • Total surface water resources per capita • People dependent on ground water resources • Surface water affordability
Water Quality	• Surface water salinity • Ground water salinity • Surface water nutrients • Ground water nutrients • Surface water microbiology • Ground water microbiology • Surface water toxicity
Freshwater Ecosystem Integrity	• Riparian vegetation • Aquatic macro-invertebrate composition • Fish community health • Aquatic habitat integrity

Source: DEAT, 2002.